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PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

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THE

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PHILOSOPHICAL JOURNAL.

Notes on the Prior Existence of the Castor Fiber in Scotland, with its Ancient and Present Distribution in Europe, and on the Use of Castoreum. By CHARLES WILSON, M.D., Fellow of the Royal College of Physicians, Edinburgh.

THE Castor Fiber or Beaver, long an animal of great interest to the physician and the naturalist, is evidently fast disappearing from the countries of Europe. Yielding to the progress of that civilization, to which it is obnoxious from its habits, while valuable for its spoils, it has already seceded wholly from many tracts which it formerly inhabited; and now only finds refuge in a few remote and secluded haunts, where it still seeks to shelter itself in a precarious and always decreasing security. Before it be finally lost from among us, it must be interesting to consider where were formerly its principal homes, whether in our own or in foreign lands, as in what spots it yet lingers. The castoreum which it supplies to medicine, a drug dignified by a celebrity of more than two thousand years, and highly valued even at the present day by many continental physicians, is also vanishing rapidly from among the approved resources of practice in this country, and must, in all probability, speedily become beyond attainment elsewhere. A few notices of its former and present relations to pharmacology and medicine cannot be out of place, at a time which thus marks an era, if not the near close, of its history, along with that of its source. Even in Asia, we need hardly add, or in its comparatively recently disturbed haunts in the New Continent, the beaver, though still surviving in large numbers, seems already threatened with a similar extirpation, for whatever period it may protract its existence.

That the beaver was at one time indigenous in Scotland has been long known, and has, especially, already been noted by Dr Neill of Edinburgh, in an interesting paper* read in 1819 before the Wernerian Natural History Society. Dr Neill adduces two then known examples of the occurrence of the remains of the animal. The record of the first instance is derived from the Minutes of the Society of Antiquaries of Scotland, dated in December 1788; where it appears that Dr Farquharson presented to the Society the skeleton of the head and one of the haunch-bones of a beaver, found on the margin of the Loch of Marlee, a small lake in the parish of Kinloch, in Perthshire, near the foot of the Grampian Mountains. The lake had been partially drained for the sake of the marl which it contained; and, in the process of excavation, under a bed of peat-moss between five and six feet thick, the beaver's skeleton was discovered. In a neighbouring marl-pit, a pair of deer's horns, branched, and of large dimensions, were found nearly at the same time; and, along with these, two bones, which our eminent anatomist Dr Barclay suggested to have been probably the metatarsal bones of a large species of deer, contemporary with the beaver, but now, like it, extinct in our country. The relics of this beaver are still preserved in the Museum of the Royal Antiquarian Society in this city, where, like Dr Neill, I have myself examined them. They appear to be those of an animal which had reached maturity. The back part of the cranium is gone, and the left zygomatic arch is broken; but the "haunch bone," or left os innominatum, is entire. A part of one side of the lower jaw-bone is also broken, and here only some remains of the very characteristic incisors still exist. The bones are dyed of a deep chocolate colour, the natural result of their long contact with the peaty substance.

The second instance adduced by Dr Neill occurred in October 1818, on the estate of Kimmerghame, in the parish of Edrom, near the head of that district of Berwickshire called the Merse. In the process of draining a morass called Middlestots Bog, there was found, at the depth of seven feet from the surface, under a layer of peat-moss of that thickness, what appeared to have been the complete skeleton of a beaver, dispersed, however, in rather a promiscuous manner, as if through the gradual separation of the parts by unequal subsidence. The remains lay upon a surface of marl, in which they were partly imbedded, and partly in a whitish layer of mossy substance immediately superjacent. Only the denser bones of the cranium and face, and the jaw-bones, retained sufficient firmness to fit them for being removed and preserved in a dry state. Several of the long bones and the vertebræ, though they seemed perfect while lying *in situ*, crumbled under the touch, or after exposure. Near the same spot were found a pair of horns, of great size, and with fine antlers, belonging to the large species of deer already mentioned; and, among the vegetable remains in the peat, were the shells of filberts, with the wood of birch and alder, and that of oak in less abundance. The skull and lower jaw-bone are now in the museum of our university. Both, as described by Dr Neill, were entire, with all the incisors perfect, their cutting edges sharp, and the peculiar coloured enamel, found alike in the recent beaver, still subsisting on the outer convexity, though deepened to an almost jet-black. The molars were also complete. This is still the condition, with the exception that the right zygomatic arch is now imperfect. The animal, as in the preceding instance, appears to have been of mature, though not of advanced age. It is proper to add here, that, on the testimony* of the writer of the Statistical Account of the parish, several other heads of the beaver were then found in the same deposit, but in less perfect preservation. We have thus approximative evidence of the ancient existence of a colony in the locality.

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* Memoirs of the Wernerian Natural History Society, vol. iii. (1821), p. 207.

Of a third instance of the discovery of the remains of the beaver in Scotland, a verbal report was given by me, in 1843, at a meeting of the Berwickshire Naturalists' Club, and is noticed* in the late esteemed Dr Johnston's sketch of its proceedings for that year. On the verge of the parish of Linton, in Roxburghshire, there is a remnant of what has evidently once been a far more extensive loch, which had skirted for some distance the outer range of the Cheviot Hills, but which, from some alteration of the levels, has now, for the most part, gradually drained itself off to the westward. Into this loch had flowed the waters of the Cheviots, entering it, as the little river Kail, by a narrow gorge towards the eastern extremity: and it is doubtless through the agency of this often impetuous current, that those alterations have chiefly been effected which have diverted the stream from what is now the narrow limits of Linton Loch; and left it contracted to a few stagnant pools, imbedded in a deep but not extensive morass, from which, however, still flows a considerable body of water by an artificially constructed channel. The near vicinity of the loch presents many localities of interest, as well in legendary lore as from later associations. The hollow at Wormington, still known as the "worm's hole," marks, according to the familiar story, the ancient haunt of a monstrous serpent or dragon, the destruction of which, by William de Somerville, obtained for him the gift of the surrounding barony from William the Lion. The little knoll, consisting wholly of fine sand, on which the church of Linton is built, has seemed to the peasant to justify the tradition, that its elevation was the work of two sisters, who sifted the heap as a voluntary penance, to expiate in a brother the crime of murder. The traces of the foundations of the neighbouring fortalice, still lurking under their covering of green sward, recal the memory of more than one of the scarcely less stirring, while more authentic scenes of border warfare; and closer to the loch, perched above its southern margin, we have the little possession of Wideopen, the inheritance of the poet Thomson, who is said to have gathered here, among the storms of the hills, many of the materials for the admirable descriptions in his poem of Winter. Through the adjoining tract of the Cheviots, spreads that range of which it could be said, as in the ballad of the Battle of Otterbourne:—

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* The Statistical Account of Scotland: County of Berwick (1841), p. 267.

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* History of the Berwickshire Naturalists' Club, vol. ii., p. 48.

"The deer runs wild on hill and dale,
The birds fly wild frae tree to tree."

Few places, therefore, could be more appropriate for the discovery of any remains which were to aid in giving body to our traditions, as in forming a link between remote and existing states of civilization.

The moss, which constitutes the body of the Linton morass, is variable in depth, and covers a very extensive deposit of marl, to obtain which, for agricultural purposes, operations on a considerable scale were undertaken by the tenant, Mr Purves, by whom the relic of the interesting animal, found in the course of these, was placed in my hands, and to whose intelligent observation I am chiefly indebted for the particulars of its discovery. In digging about twenty yards from the margin, and after penetrating a thickness of moss of about eight feet, the marl was reached, and upon its surface was found a skull, in excellent preservation,* easily recognised by me, on examining it, as that of a beaver. Either no other parts of the skeleton had remained preserved in its contiguity, or they had failed to attract the attention of the workmen; the probability being that, from the slighter texture of most of the other bones, they had been less able to resist entire disintegration, or had crumbled on exposure. The remains of deer and other animals were also discovered on the surface of the marl, at about the same distance from the margin; but, at other places, the horns and bones of deer, and among these a lower maxilla, were found fourteen feet beneath the marl itself, yet still within its layers, or at about an aggregate depth of twenty-two feet. Among the remains preserved and placed before me were horns of the red-deer, with metatarsal bones, evidently also of animals of the deer species, all betokening individuals of once stately dimension; while the left tibia of an ox, doubtless the *Bos primigenius*, which was found imbedded at a depth of seven feet within the marl, I computed must have belonged to an animal measuring at least six feet, or, with the hoof and soft parts entire, fully half a foot more to the summit of the shoulder. The moss, at the part covering these remains, might be viewed as divided into three layers. The upper of these, approaching to about three feet in thickness, consisted of the traces of comparatively fresh vegetation: the second layer, measuring about two feet, had a less firm consistence, and changed its colour of a greenish brown, when moist and newly exposed, to almost a white when dry: the third layer extended to about four feet, but in some places to a much greater thickness, and was almost black, holding imbedded, in various grades of preservation, many and not mean remains of the primeval forests, such as trunks of trees, for the most part hazel and birch, with an intermingling of oak, some measuring from two to even four feet in diameter; and, along with these, large quantities of hazel nuts, heaped into masses, as if gathered and swept from the upper woodlands by the mountain freshets. In some places gravel was found deposited above the moss, bearing testimony to the action of similar currents.

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* The skull is now placed in the Museum of the Tweedside Physical and Antiquarian Society at Kelso; a remarkable collection, considering its position in a small country town, but which would have fulfilled a better design, and one more worth adopting elsewhere, had it been restricted, as originally planned, to the illustration exclusively of the Natural History and Antiquities of the immediately surrounding district.

The stratum of marl varied from two, to almost eighteen feet in thickness, and consisted of the usual fresh-water shells, but mainly of *Planorbis* and *Limnœa;* the greater part being of almost microscopic dimensions, yet often in the most entire preservation. Where the relic of the beaver had been deposited, the marl, however, to judge from portions taken from within the skull, seems to have been largely, if not entirely, composed of infusoria. On the application of an acid, after a smart effervescence, with the disappearance of a considerable bulk of the material, there remained amorphous, ferruginous-like masses, and, abundantly interspersed with these, the silicious coverings of the animalcules, if they be really animal organisms. Among them I distinguished *Epithemia Argus, sorex, turgida,* and *longicornis; Cyclotella operculata; Gomphonema constrictum; Nitzschia sigmoidea; Surirella craticula; Cymbella helvetica; Navicula lanceolata;* and, probably most abundant of all, *Himantidium arcus.* The remains of the mammals found in contact with the peat, including the skull of the beaver itself, were of the usual dark tint acquired from that substance: those deposited in the marl preserved more nearly their natural colour. Near the margin of the loch, and about seven feet deep in the moss, were found an arrow-head, and two or three iron horse-shoes; the latter of small dimensions. Could we regard these horse-shoes, and this individual beaver, thus found at nearly the same depth in the moss, as having reached their position there coëtaneously, as, perhaps, approximatively we may, the furthest limit to which our archæological experience would entitle us to go back for this would probably be the Anglo-Saxon period; but our surmise as to the era would still be a rude one, and within it, or even possibly long after it, though scarcely before, we must be prepared to allow a wide range.

To these proofs of the prior existence of the beaver in Scotland, derived from the actual discovery of its remains, it is easy to add others of a similar description from various countries, in which it has evidently also been once indigenous, but in which it has alike ceased to exist. An early instance, in England, is that in 1757, by Dr Collet,* who mentions the heads of beavers as having been found, along with bones of other animals, in a peat-pit near Newbury, in Berkshire. Similar discoveries of remains, as quoted by Professor Owen,† have been made at Hilgay, in Norfolk, where they were found associated with those of the great Irish deer. A lower jaw, found in 1818 near Chatteris, is recorded in the Proceedings of the Cambridge Philosophical Society. In at least three other instances, all referred to by Professor Owen, the remains of the beaver have been found in the peat-mosses of Berkshire, and in the Cambridge fens; while other discoveries, at Mundesley, Bacton, Southwold, and Happisburg in Norfolk, and at Thorpe in Suffolk, appear under relations which seem to carry the antiquity of the beaver in England farther back into the tertiary period, and ought probably to be referred to a different, yet closely allied species. In Denmark, we learn from a highly interesting communication by Professor Steenstrup‡, that a lower jaw, with the greater part of the extremities of a beaver, evidently belonging to an individual animal, was discovered in the moss of Christiansholm; and that a tooth has also been found in Fyen, all the other traces hitherto of its former existence within the Danish territories having been limited to Sjælland. Specimens of stems, evidently gnawed by the beaver's teeth, were taken from Mariendals moss, the special locality being regarded by the Professor as probably occupying the former bed of a stream, which had been once its habitat. Similar stems, from two to four inches thick, with beaver marks, were seen in Brönsholm moss, in great quantity, and laid with remarkable regularity; while a like deposit, at a depth of about three feet, occurred in a moss near Lyngsbye.* In these interesting facts, we appear to recognise distinctly the remains of the dams of the beaver, and the familiar evidences of its singular constructive faculties. Perhaps we may further refer to a period not remote from that of these relics in the mosses, the location of three beaver's teeth, in a greatly damaged condition, at the side of a human skeleton, which was found in a tomb of an ancient Lap, opened recently† at Mortensnæs, on the Varangerfjord, in the extreme north-east of Norway. A stone hammer, bearing marks of use, lay in the same grave.

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* Philosophical Transactions for 1757, p. 112.

† History of British Fossil Mammals and Birds, pp. 184, 190.

‡ Oversigt over det Kgl. danske Videnskabernes Selskabs Forhandlinger, 1855, p. 381.

When we turn from these sufficiently decisive indications of the ancient resorts of the beaver, and seek for other evidences of a historical, topographical, or documentary character in relation to its former existence in Britain, if these are not presented to us in any marked abundance, neither are they wholly wanting, or devoid of curiosity and interest. We have no earlier, and can scarcely have any more authentic, notices of this description than such as are derivable from the names of places, which our ancestors often rendered commemorative of some leading feature or specialty of the site. Thus, in the nomenclature of the Anglo-Saxons, as exhibited in the "Codex Diplomaticus Ævi Saxonici," we find the names, *Beferburne, Beferige, Beferic, and Beferluc.*‡ In the Glossary of Ælfric, the Anglo-Saxon Archbishop of Canterbury near the close of the tenth century, appended to his "Grammatica Latino-Saxonica," we have the *Befer* rendered as the *Fiber* or *Castor Ponticus*. The annex in each name: *burne* (brook), *ige* and *ic*, or *icg* (island), and *luc* (inclosed space, fence), is entirely apposite, and suggests to us so perfectly the ordinary habitat of the animal, or the construction of its dam, as to establish at once the certainty of its having existed at the individual place in the Anglo-Saxon period. Again, in an ordinance of Edward I. for the government of Scotland, dated in 1305, we find William of *Bevercotes* named as chancellor of the kingdom; and here we are reminded of the huts (Anglo-Saxon *cote*), of the beaver, a cluster of which had evidently led to the territorial designatien of this dignitary. There is a "Bevere Island," which lies about three miles north of the city of Worcester, which is popularly understood to have been so denominated from its having been frequented by beavers:* and doubtless it might be easy to glean elsewhere many similar local designations. Leland, for example, writing prior to the middle of the sixteenth century, mentions the town of Beverley, in Yorkshire, as having for its insignia, on its public seal, the animal "quod vocatur Bever;" and, in a subsequent passage, on what purports to be the authority of an uncertain writer of a life of St John of Beverley, he introduces the name of the place as, "Deirewald, locus nemorosus, id est, sylva Deirorum, postea Beverlac, quasi locus, vel lacus castorum, dictus à castoribus quibus Hulla aqua vicina abundabat."† While we give due weight to this, as advanced unquestioningly by one of Leland's habits of investigation, writing at his time, yet while citing one of an age far anterior, it appears evident, nevertheless, that not only was the beaver then utterly extinct in the country, but that, at no long period after the Anglo-Saxon era, it had already ceased to be familiarly known in England.

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* Oversigt over det Kgl. danske Videnskabernes Selskabs Fordhandlinger, 1855, pp. 2, 382.

† Forhandlinger af danske Videnskab. Selsk.: Illustreret Nyhedsblad, (Christiania, 1856), pp. 97, 104.

‡ Leo, Local Nomenclature of the Anglo-Saxons, p. 14.

We have proof of a more direct nature of the actual existence of the beaver in Wales, at this early period of the civil history of our country, but nearly expiring period of the history of the English beaver.* In the code of Hywel Dda, framed towards the commencement of the tenth century, and therefore considerably before the time of Ælfric, we find† the animal valued at 120 pence; and, as in the following section we find the skin (*croen Llosdlydan*) appreciated alone at precisely the same amount, we infer that the latter merely was regarded, and that neither the carcass as food, nor the castoreum as medicine, was then held in esteem by the Welsh. But to show how highly the skin was prized, and of course as a fur, we may contrast this valuation with that of the ox and deer, each of which is rated at eightpence; while that of the goat or sheep is rated at only a penny. An oak tree was as precious to the mountaineers; for, if sound, it was valued also at 120 pence. Among the tolls licensed to be levied at Newcastle-upon-Tyne, in the time of Henry I., we find the *tymbra beveriorum* fixed at fourpence; and this, it is important to note, appears to have been an export duty.‡ At least half-a-century after the period of Henry, and more than two centuries after that of Hywel Dda, we have the evidence of a witness of remarkable intelligence, that the beaver still survived as indigenous in Wales. Silvester Giraldus, travelling in that country in 1188 with Archbishop Baldwin of Canterbury, who preached there that crusade in which he afterwards followed Richard Cœur de Lion to the Holy Land, and perished at Acre, tells us, in speaking of the river Teivi, that it retained a special notability: "inter universos namque Cambriæ seu etiam Loegriæ fluvios, solus hic castores habet." He then proceeds to give an account of the habitat of the animal at some deep and still recess of the stream; describes its dams and huts, and its methods of construction, with considerable minuteness; and records the dangers to which it is liable on the score of its skin, which is coveted in the west, and the medicinal part of its body, which is coveted in the east: while he adds, though with evident scruple as to the orthodoxy of the practice, that in Germany, and the northern regions, great and religious persons "tempore jejuniorum," eat the tail of the fish-like creature, as having both the taste and colour of fish. Giraldus informs us further, that beavers were then reported to exist also in Scotland, but likewise only in a single river, and in scanty numbers.*

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* Allies, Antiquities of Worcestershire, pp. 151, 152.

† Leland, Collectanea de rebus Britannicis, tom. iv., pp. 34, 100.

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* Of a more remote but wholly uncertain antiquity, yet worth mentioning, is the circumstance that the beaver seems to have occupied a prominent place in the old Druidical mythology of Wales, especially in relation to the tradition of a general deluge. It is said to have been even an object of worship in ancient Persia.

† Leges Wallicæ, curante Wotton, lib. iii., cap. v., sect. xi. 40; sect. xii. 10, De pretiis animalium ferorum et cicurium.

‡ Acts of Parliament of Scotland, vol. i.; preface, p. 34.

Dr Neill, who refers to Giraldus, takes an opportunity of stating,† in allusion to this concluding observation, that no mention of beavers occurs in any of the public records of Scotland, now extant. To this, however, there is at least one exception. In the *Assisa Regis David de Tolloneis*, cap. ii., supposed to date towards the middle of the twelfth century, but evidently founded on the English Act of Henry I., the export duty is fixed, "of a tymmyr of skynnis of toddis quhytredys martrikis cattis *beveris* sable firrettis or swylk uthyr of ilk tymmyr at ye outpassing iiij^{d}.‡" If we note here that the duty is one upon exportation, "ad exitum," or "outpassing," we can scarcely conclude otherwise than that the beaver was then met with in the country, and apparently even in considerable numbers, so that its fur was an ordinarily recognised article of commerce, of native produce. To judge, however, from the language of the Scottish rendering of the Latin original of the Assize of the first David, which we have here purposely adduced, we must regard its regulations as having remained in force till a much later era; and probably till that of the second king of the name, or till about the middle of the fourteenth century. But the animal which was already reported as rare in the time of Giraldus Cambrensis, yet which seems to have been held entitled to continue as furnishing an article of impost more than two centuries after, appears, in still another century, to have shrunk into such narrowly limited numbers, that it was at last no longer deemed necessary to retain for it a place in a fiscal enactment. In 1424, at the first parliament of the first James, the martin, polecat, fox, and other skins, are still named as articles bearing an export duty, but the beaver is omitted.* Yet, at even a later period, when we find Hector Boethius reporting, after the lapse of almost another century, that the wild region of Loch Ness contained then, not only a great abundance of wild animals such as stags, horses, and roes, but "ad hæc Marterillæ, Fovinæ ut vulgo vocantur, Vulpes, Mustellæ, *Fibri*, Lutræque in incomparabili numero, quorum tergora exteræ gentes ad luxum immenso precio coemunt,"† it is with the inclination, led on by the Assize of David, and by the narrative of Giraldus, with both resting securely on the discoveries in our mosses, still to extend to him a more entire confidence than has been customarily conceded by others. Bellenden, in translating this passage, while he omits the stags, roe-deer, and otters, preserves the "mony martrikis, *bevers*, quhitredis, and toddis," with the intimation that "the furringis and skinnis of thaim are coft with gret price amang uncouth marchandis."‡ The very license which Bellenden appears to have allowed himself in his translation, seems to me here to lend weight to the authority of the original statement. He may have omitted the kinds of deer, and the otter, as animals too notoriously abundant everywhere to require remark: but, whatever was his motive, that he should have excluded the one, and retained the other, showed the probability of some grounds for a selection; and seems to give greater authenticity to that which he left thus, in a more marked manner, with the support of a conjunct testimony. As to the "incomparable number," this must be held to apply to the animals in the aggregate, and not to the beaver in particular; and the rarity of this was certainly not the less likely to enhance its price, that it had annulled its importance as a source of revenue. Upon the

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* Silvester Giraldus Cambrensis, Itinerarium Cambriæ, seu laboriosæ Baldvini Cantuarensis Archiepiscopi per Walliam legationis accurata descriptio, lib. ii., cap. 3.

† Mem. of Wern. Nat. Hist. Society, vol. iii., p. 211.

‡ Acts of Parliament of Scotland, vol. i., p. 303. The *timmer* still denotes in Sweden a bundle of forty skins. From a citation in Ducange (Gloss. Med. and Inf. Latin. V. Timbrium), the timber in France, in the year 1351, contained sixty skins. The term in this country appears to have usually denoted the number of forty.

* Laws and Acts of Parliament of Scotland (1682), part i., p. 6.

† Hector Boethius, Scotor. Hist.; Regni descrip. (1527), F. ix.

‡ Boece, translated by Bellenden (1536), cap. viii., F. xxxiii.

whole, it seems thus fairly admissible, that the existence of the beaver in Scotland may be authentically traced as far down as to the beginning of the sixteenth century, though doubtless for long in extremely limited numbers, and, naturally, only in deeply secluded localities. Sibbald, writing towards the close of the century which follows,[*] adduces merely the statement of Boece, and, without rejecting it, professes his ignorance as to whether the animal was still indigenous. It may be noted incidentally here, that the Gaelic Dictionary of the Highland Society of Scotland contains the *dobhran-leasleathan* as the designation of the beaver; while we remark, at the same time, the close analogy of this term to the *llosdlydan* (the broad-tailed animal) of the code of Hywel Dda. Reverting to Wales, the celebrated Camden[†] speaks of the Teivi as "olim castoribus, nunc salmonibus abundans." In the later edition by Gough, it is added,[‡] that in the Conway there is a deep, wide, still water, called to this day by a name denoting the beaver's pool. Ray,[§] followed by Pennant,[‖] each referring to Giraldus, names also other places in Wales which are reputed to have been the former haunts of the animal, as we have shown that similar spots are recognisable in England.

If we proceed now to the history and distribution of the beaver in the other countries of Europe, we find that the facts, scanty and dim, and mingled with error at first, slowly mass themselves into greater copiousness, and acquire greater precision. If the fable of the beaver (*ὁ κάστωρ*) be really the production of Æsop, and that writer have lived, as we have reason to believe, five centuries and a half before the Christian era, the popular notion or fiction embodied in it, that the animal when chased, knowing the object of the hunter, usually itself performed the operation of castration, and resigned the spoils for which it was pursued, that it might be allowed to escape in safety otherwise, gives us a very reverend antiquity to show, not only for the figment itself, but for the value which already, at so remote a period, may be inferred to have attached itself to the uses of castoreum in medicine. Æsop, who merely speaks of the animal besides as a quadruped living in stagnant places,* points his moral, that a prudent man will thus always be ready to sacrifice his wealth for his safety: while further, if we are to credit Horapollo, a writer at an early period of the Christian era, it was this popular notion also which had obtained for the beaver a place among the Egyptian hieroglyphics, but here as the symbol of an unfortunate man,† though a diligent investigator of this department of archæology assures me that the emblem does not now occur in any of our known collections. Herodotus,‡ writing little more than a century after Æsop, reports the beaver as inhabiting a large lake in the country of the Budini, who are understood to have been a tribe in Scythia, to the east of the Don, and within the limits of Europe. Aristotle adds nothing to our information as to the geographical range of the animal, almost nothing as to its manners, and little as to the special nature and locality of its habitat, beyond that it haunts lakes and rivers generally.§ It is a comic poet, Plautus, about two centuries before Christ, that, in a fragment from one of his lost plays,‖ appears to give us the first special indication of a favourite food of the beaver, in the line: "Sic me subes cotidie, quasi fiber salicem." No habitat in Europe is assigned to the beaver by Pliny, and even he adds nothing to the details as to its manners, unless that he refers to its custom of cutting down trees with its chisel-like teeth: "arbores juxta flumina, ut ferro, cædit."** The great encyclopedist mentions that the best castoreum was brought from Pontus (whence the animal was known as the *Fiber Ponticus*), and from Galatia,†† both in Asia Minor; and, possibly we may now conjecture, chiefly from the river Halys, the modern Kisil-Yrmak, or Red River, in which the beaver is still known to be abundant. The next quality of the castoreum, Pliny reports as coming from Africa; thus in so far warranting the testimony of Horapollo, that the animal was known to the Egyptians; though it appears probable that it really never inhabited any of the African countries, and that the drug was brought thither, in all likelihood from Persia, through the usual channels of traffic, of which the Egyptian cities were for long important centres.

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[*] Scotia Illustrata (1684), part ii., lib. iii., p. 10.

[†] Britannia (Lond. 1600), p. 586.

[‡] Gough's Camden, vol. ii., p. 560.

[§] Synopsis Methodica Animalium (1693), p. 213.

[‖] British Zoology (ed. 1812), vol. i., p. 122.

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* Æsopi Phrygis Fabulæ (ed. 1541), p. 133.

† Hieroglyphica Horapollinis; *fide Cod. Aug. corr.* (1595), lib. ii., sec. 65, p. 100.

‡ Historia; Melpomene iv., sec. 109.

§ De Historia Animalium, lib. viii., cap. v.

‖ Comœdiæ, *ex rec.* Gronov. (1669), p. 1214.

** Historia Naturalis, lib. viii., cap. xxx.

†† Ibid., lib. xxxii., cap. iii.

Strabo, in so far as I have observed, is the first after Herodotus who explicitly names the beaver as a native of Europe, mentioning it as found in the rivers of Spain,* with the sole remark that its castoreum was inferior to that of Pontus. Dioscorides contributes nothing as to the history of the animal, unless that he adds his support to the correction of the popular error upon which the fable of Æsop was founded,† which had already been exposed however by Pliny, on the authority of Sextius; and which indeed remarkably enough, considering the other singular characteristics truly belonging to the animal, seems to have constituted, along with the castoreum itself, its great claim to notice with the poets of antiquity, among whom it is referred to by Lucretius, Juvenal, Ovid, and Virgil, as, among the prose writers, by Cicero. Advancing to the time of Oppian, all is still nearly barren with regard to the geographical distribution, and the true, leading, and peculiar features in the habits and instincts of the beaver; this author only presenting the superstitious delusion, that the call of the animal heard by a man portended his death,‡ thus rendering it worth noting, that even to this day the Polish and Bohemian peasants assign to the beaver a cry of intense plaintiveness. At a still later period, Ælian§ adds nothing to the meagre details of his predecessors. We thus see that, beyond the early notice of Herodotus with reference to the Budini, and that of Strabo, long afterwards, in relation to Spain, we have in none of the principal classical writers, whether Greek or Roman, any notice of the existence of the beaver within the European countries; and, still less, any allusion to those peculiar instincts, whether of building or colonizing, which have since conferred upon the animal so wide a notoriety. It would be unwarrantable, of course, to infer from this silence, singular because on points so apparently notable and interesting, that the beaver was really then unknown as indigenous in Italy, or in the other countries within the bounds of Europe, visited or occupied by these great masters of ancient civilization. All our persuasions, on the contrary, and scarcely any one more than that derived from the allusion of Plautus to its attacks upon the willow, lead us to an opposite conclusion, however defective our evidence: and we must remember that we find this restricted information as to habits also in those among the writers whose opportunities ought to have been scarcely questionable; Æsop, Dioscorides, and Oppian having been natives of Asia Minor, where the animal was notoriously abundant, where it was therefore open to observation, and where even a recent traveller* informs us that such numbers still exist, that the Kisil-Yrmak alone might yield a supply of from 1000 to 2000 skins annually.

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* Strabonis Geographia (ed. 1571), lib. iii., p. 172.

† Dioscorides, De Mat. Medica; Interp. Marc. Vergilio Florentino (1529), p. 185.

‡ Halieutica, lib. i., v. 397.

§ De Natura Animalium, lib. vi., cap. xxxiv.

If we have this almost total silence, as to the manners and habitats of the beaver, among the esteemed writers of the best ages of antiquity, and with reference to their own countries, we can scarcely expect any more extended or specific information from the few authors who appeared in the darker ages that followed. We must descend to the thirteenth century, in order to encounter at last an observer on the continent, in various respects a man of remarkable learning and genius, whose notices are of a more direct and precise nature. Albert von Böllstadt, or Albertus Magnus, Bishop of Ratisbon, in one† of his many voluminous treatises, refers to the beaver, and grounds part of his statements on his own local experience: "sicut frequenter in partibus nostris est compertum." The "partibus nostris" may apply to the Danube, where Albertus had held his episcopate; or to the Rhine, the scene of his retirement, and where most of his works were composed. Like our Giraldus, at even an earlier period, he describes the building instincts of the animal; and speaks of its cutting down trees with its teeth, in considerable quantities, and constructing huts on the banks of the rivers, as well as burrows, which it inhabited. The huts had sometimes two, or even three apartments, and these were on different stories, so that the beavers might be provided with a higher or a lower residence, according to the varying height of the river. In the fifteenth century, Cuba* speaks of the beaver as living gregariously. George Agricola, the celebrated metallurgist, mentions it long afterwards, in a treatise bearing internal evidence of having been written in 1547,† as hunted in Germany, in his time, for the sake of its tail which was eaten, the skin which was used for dress, and the castoreum which was employed in medicine; and he repeats, with considerable circumstantiality, the accounts of the skill and perseverance of the animal in the preparation and adaptation of the materials for its constructions. Bruyerin also‡ mentions it as occurring in multitudes in various tracts of Germany. Olaus Magnus, the Archbishop of Upsala in the sixteenth century, records some particulars as to the existence of the beaver in the Scandinavian countries,§ where he describes it as found in the greatest abundance, and as constructing its two and three chambered houses with wonderful art: and far later, in the middle of the eighteenth century, we have the testimony of Pontoppidan,‖ that in Norway they were still numerous, there being then a considerable trade in their skins, and in castoreum, at the fair of Elverum; while he names, as particular localities where they were found, Solloer, Osterdalen, and Jemteland. Linnæus,¶ in his Fauna of Sweden, includes the beaver as inhabiting lakes and rivers, especially in Lapland.

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* Brandt, Mém. de l'Acad. Imp. des Sciences de Saint-Peterbourg, 6me série Sciences Naturelles, tom. vii. (1855), p. 81.

† Opera Universa, tom. vi.; De Animalibus, tract. ii., cap. i., p. 584.

Belon, whose early death by assassination, in the Bois de Boulogne at Paris, was regretted as a loss to the science of natural history, which he had cultivated with a success and discrimination beyond his period, speaks of the beaver* as "vulgo noster *Beverus, un Bieure.*" Thus familiarly denoting its residence in France, he describes it further as an animal abounding elsewhere in Europe, and as frequently kept tame among the Burgundians, Lorrainers, and Austrians. Rondelet, who mentions it as found in the Rhone, and gives an interesting notice of two tame individuals kept by the Bishop of Montpellier,† was the first to present a true description of the follicles containing the castoreum, hitherto erroneously believed, and, in the fashion of the early writers, universally reiterated, to be the testes of the animal. Bruyerin‡ reports the beaver to have been frequently met with in the Saône. Saumaise, in a work§ of immense and diffuse learning, speaks of it also for France, as "nostrum *bièvre.*" Pomet,‖ writing in the seventeenth century, mentions it in the Rhone, the Lisère, and the Oise; says that great numbers were taken along the Elbe; and extends its range further, though it does not appear upon what authority, to Spain, Savoy, and Italy. In Switzerland, we are told by Conrad Gesner,¶ beavers were abundant "circa Arulam flumen, Ursam, et Limagum nostrum (the Aar, Reuss, and Lint);" and he adverts to an example, newly captured, which he had an opportunity of examining while he was occupied in writing on the subject. In another treatise** he says they live only by rivers, or, as some think, lakes, preferring the still parts or bays of the former. Gesner assigns also a habitat to the beaver in Italy, near the mouth of the Po: but of this we find no direct confirmation, or even of their having been positively at any time indigenous anywhere in that country, unless in the fact that its molar teeth are reported to have been found in the Valdarno;†† a notice, regarding which the Italian translators of the Dictionnaire des Sciences Naturelles offer no further illustration. Dante, as little as his great precursors, the poets of Rome, does not recognise it as a native of Italy, but refers to its presence in the Danube :—

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* Ortus Sanitatis: Tractatus de Animalibus (1491), cap. xxxi.

† De Animantibus subterraneis: Opera (1556), p. 484.

‡ De re Cibaria, lib. xiii., cap. xxxii.

§ Historia de Gentibus Septentrionalibus (1555), lib. xvii., cap. v., p. 604.

‖ Natural History of Norway, part ii., p. 26.

¶ Fauna Suecica (1746), p. 9.

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* De Aquatilibus (1553), p. 28.

† De Amphibiis (1554), p. 237.

‡ De re Cibaria, lib. xiii., cap. xxxii.

§ Plinianæ exercitationes in Caii Iulii Solini Polyhistora, vol. i., p. 186.

‖ Complete History of Drugs, vol. ii., p. 244.

¶ Historia Animalium: De Quadrupedibus, lib. i., p. 337.

** De Aquatilibus, p. 222.

†† Dizionario delle Scienze Naturali (Firenze, 1833), vol. v., p. 403.

> "E come là tra li Tedeschi lurchi
> Lo bivero si assetta a far sua guerra."*

Marcellus Vergilius, an Italian translator of Dioscorides, when occupied with the castoreum, takes no opportunity of hinting that the beaver was known as indigenous ;† and Matthioli, in his commentaries on the same Greek author, published at Venice,‡ while he assigns to it a wide distribution throughout Upper Germany, along the course of the Rhine, and in the provinces watered by the Drave and the Save, is alike silent with reference to Italy. Matthioli had an opportunity of dissecting two beavers, presented to him by an Austrian archduke. "A Rondeletio edoctus," he confirms the views of the French physician with regard to the castor-sacs ; and speaks of the wonderful artifice of the animal in the construction of its huts, built of several stories. The noted Scaliger mentions the beaver as existing in France and Germany,§ but does not claim it for his own country ; and, stating that he never saw one tame, asks, not very pertinently with regard to experience elsewhere : "semipiscis enim qui cicuretur ?" Aldrovandi,‖ a better and more special authority, was not aware of its existence near the Po, as Gesner had asserted.

As to Spain, we have not been more successful in our search for later information, to confirm the statement of Strabo. It is true that some Arabian writers are said to indicate the fact of the beaver being a native of that country ; but, excluded from these, I have seen nothing to corroborate the assertion in the works of the Spanish physicians whom I have been able to consult. The learned Laguna,¶ in a note appended to his translation of Dioscorides, says that it is found at every step (*à cado passo*) along the whole course of the Danube, but principally in Austria; while he adds no allusion to its existence, either then or before, within the limits of his own country. Velez de Arciniega,* too, in a work specially devoted to the animals used in medicine, and treating, among these, of the beaver, gives no indication of its having been found in Spain: but it must be admitted that, both in description and history, the accounts in this author are very meagre; and we need only accept from him here, as doubtless a good Catholic, his confirmation of the statement, that the tail was eaten as fish in Lent, but the carcass, he says, is flesh. In a recent Spanish Pharmacopœia,† it is the Russian castor that is directed. Admitting, however, the testimony of Strabo, with the unquestionable evidence of the fossil teeth in the Valdarno, as sufficient for Spain and Italy, we have already accumulated proofs, besides, of the former existence of the beaver in Great Britain, France, Switzerland, Germany, Austria, Russia, Norway, Sweden, and Denmark. When we join to these the fact, that remains of the animal have been found by M. Morren in the peat of Flanders, we have adduced distinct evidence of its distribution, and often in great numbers, over nearly the whole expanse of Europe. It is of less importance here, to point further to the discovery of their remains in those countries where they are still not entirely extinct, though rapidly disappearing. It may be enough, as to these, to note merely, as additional localities, that their bones, according to M. Gervais, have been found in mosses in the valley of the Somme in France, as well as near Paris, at the confluence of the Seine and Marne; and in the department of the Aube, in the cave of Lunelviel, and other situations.‡ They are also reported§ to have been observed among the lignites in Switzerland.

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* Inferno, cant. xvii., v. 21.

† Dioscorides, De Mat. Medica : Interp. Marc. Vergilio Florentino (1529), p. 185.

‡ Commentarii in sex libros Dioscoridis (1570), p. 248.

§ De Subtilitate : Exercit. 210, 211 ; p. 678.

‖ De Quadruped. Digit. Vivip., lib. ii., cap. xii., p. 282.

¶ Dioscorides, Acerca de la Materia Medica, traduzido en el vulgar Castellana por el Doctor Andres de Laguna (1555), p. 138.

From this so extensive distribution of the beaver over the fields mainly occupied by the Indo-Germanic races, we might expect a great similarity in the name of the animal throughout their kindred languages, whether in Europe or in Asia; and this accordingly occurs in a remarkable degree. Eastern scholars inform us, that in the Sanscrit the name is *babhru;* in the Pehlevi branch of the Persian, it appears, in the religious manual of the Bundehesch, as the *baovara;* and, in the others which follow, it is easy to recognise an identical root, under a customary order of mutations. Thus, in the Sclavonic, it is *bobr* and *baber*, and in the Lithuanian division it is *bebru* and *bebris:* in the Icelandic we have *bifr*, and, in the affiliated languages of Denmark and Sweden, *bæver* and *bäfver:* in the more strictly Teutonic branch, the old German is *bibar*; the Anglo-Saxon *befor*, *befer*, *beber*, or *beofor;* the German *biber;* and the Dutch *bever:* in the Græco-Latin branch the Latin *fiber* becomes, with some of the later writers and scholiasts, *bebrus*, *bever*, or *biverus*; in Italian it is *bivaro* or *bevero*; in Spanish *bibaro;* in Provençal *vibre;* and in French *bièvre*; while, on the other hand, we have a singular divarication in the Greek *κάστωρ*. In some instances, in the Celtic tongues, we have a like marked divergence, reminding us of the opinion of several philologists, that these languages were not entitled to rank among the Indo-Germanic family: but in others the resemblance is striking; while in most, as the diverging names assume a descriptive character, their origin acquires a natural independence. Lhuyd* assigns, as the Welsh equivalent, *avangk* or *adhangk;* but he also gives *lhostlydan*, which we know signifies the *broad-tailed animal*, and is therefore aptly characteristic: in the Irish he gives *beavar*, *kastar;* and again a descriptive name, *davaran loisleathan:* in the Gaelic Dictionary of the Highland Society, we have seen, the near analogue of the last is *dobhran-leas-leathan;* thus manifestly representing, like the Irish, the *lhostlydan* of the closely allied language of Wales. With the classical ancients the animal was sometimes known as the Parthian, and sometimes as the Pontic dog.

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* Historia de los Animales mas recibidos en el uso de Medicina (1613), p. 108.

† Pharmacopœa Hispana (1827), p. 3.

‡ Chenu, Encyc. d'Histoire Naturelle (1854); Rongeurs et Pachydermes, p. 67.

§ Pouchet, Zoologie Classique (1841), t. i., p. 123.

The names of localities and of individuals have risen as naturally, in foreign countries as among ourselves, from the presence of the beaver. If the ancient Bebriacum, between

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* Archæologia Britannica: tit. ii., Comparative Vocabulary; v. Castor.

Cremona and Verona, and near the Po, have thus, as has been imagined, derived its name, we have a confirmation of the statement of Gesner that it had formerly frequented this river; while we may surmise a still more probable derivation in the name of the river Fibrenus, a tributary of the Liris in Latium, an islet in which is so pleasingly described as a favourite resort by Cicero.* Biberach or Biberbach, in Suabia, Merian† writes, had its designation from the beavers which had their colonies in a brook or stream in its vicinity. This town was an old *Reichs-stadt*, and, like our Beverley, had long carried the beaver in its armorial insignia. The animal, we are told, was first borne *azure*, with a crown *gules*, on a field *argent;* but, in 1487, in consideration of an important service rendered to the Archduke Maximilian, afterwards the Emperor Maximilian I., the citizens acquired the right to have the field *azure*, and the beaver and crown *or:* a guerdon which we must suppose them to have considered adequate, as they obtained it on petition. There is besides a Bieberach on the Kinzig, a tributary of the Rhine; and on the Rhine itself we have Biebrich, probably the analogue of our *Beferige*, whence our patronymic *Beveridge*. The brothers Grimm, in their elaborate Dictionary (V. *Biber)*, give besides Biberaha, Biber, Bebra, Beberbeke and Bever, as names of places occurring throughout all districts of Germany, and as easily resolvable into indications of the old haunts of the beaver. Petersen‡ derives the ancient name of Byauærskogshæreth, in Denmark, from a like source, and alludes to the introduction of the animal into the known legend of King Snjo, in the Chronicle of Eric of Pomerania. We remark also, in Silesia and Lithuania, the Sclavonic name Bober, as that of a river; as well as in France the little river Bièvre, noted in sanitary disquisition from the Memoirs of Hallé and Parent-Duchatelet, which passes by Arcueil and Gentilly to reach the Seine at Paris. Of surnames of individuals, we have the Russian *Bobroff*, the Polish *Bobrowski*§, the German *Bibra* and *Bieber*, and the French *De Bièvre.* As to the latter, perhaps if a man were to be styled a beaver from his sagacity, as a fox from his cunning, the Marèchal de Bièvre, a famous punster, and the author of the reputed best pun extant, would, by at least one order of wits, have been considered well entitled to his designation. In England we have the surnames Beaver, Beever, and Beevor; Beavers and Beevers; with, besides Beveridge, Beaverstock, and Beverley.

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* De legibus, lib. ii., cap. 1. 3.

† Topographia Sveviæ (1643), pp. 15, 16.

‡ Nordisk Tidsskrift for Oldkyndighed, B. ii., p. 94.

§ Pott, Die Personennamen (1853), p. 668.

It is interesting to remark that, independent of the more remote evidence produced by Professor Steenstrup from the peat-mosses of Denmark, we have, in the testimony of Giraldus and Albertus Magnus, though not in the classical writers, proofs of an acquaintance with the gregarious habits and constructive instincts of the beaver, at a time long anterior to the discovery of America, and to the more widely diffused knowledge which followed gradually upon the narratives of the voyagers to the New Continent. It is surprising that Buffon, whose elegance of style so rarely appears as an excuse for carelessness and inerudition, should not only have overlooked this fact, but the evidence of all the more recent authorities we have quoted, as well as of others to a like purport occurring in his own day. The beavers of Europe, says this eminent writer, never assemble in colonies, and never construct, but merely burrow;[*] although he admits, what is not nearly enough, that in Norway, and other parts of the extreme north, their huts have been reported to be found within the last centuries. Cuvier appears to have followed Buffon, in assuming that the European beavers, at least in later ages, never build; and states the difficulty he has had in attempting to determine, whether those which now have their burrows along the Rhône, the Danube, the Weser, and other rivers, are originally different from the American species, or whether they are identical, and are hindered from building solely by their position in the nearer vicinity of man.[†] Desmoulins, also,[‡] denies that societies of beavers have ever been seen in Germany. While grateful that the eloquence of Buffon, and the comprehensiveness and precision of Cuvier, have given a charm and a solidity to natural history unknown to it before, it is to wonder the more that it should have been easy for us to supplement their inquiries, on this curious point, from sources so readily accessible. To approach even our own times, Bechstein,* writing so recently as 1801, tells us that on the Elbe, near Kähnert, the property of the Prussian minister, Schulenberg, there were then many beavers, which constructed dams on the side channels, or arms of the river, where there was calm water. Near Wittenberg also, they lived in societies, and formed dams. In the vicinity of Hettinghausen, on the Lippe, they built their dams, and were found in considerable numbers; as well as higher up the river, in the territory of Paderborn. In these localities, their constructions are stated to have been so skilful as to rival those of Canada, though the colonies were less numerous. The trees they cut down were willows and poplars. Oken† mentions a beaver-hut on the Yesil, in the duchy of Cleves, which stood six feet high, with two chambers over each other, the upper having three, and the under four cells; and he refers to a paper by Meyerink, in the Berlin Natural History Transactions for 1829, describing a colony settled for upwards of a century on the little river Nuthe, half a league above its confluence with the Elbe, in a sequestrated canton of the district of Magdeburg. In 1822, it contained from fifteen to twenty individuals: they had burrows; built huts eight or ten feet high, using trunks and branches of trees, along with earth; and constructed a dyke. Martius, writing in 1837,‡ speaks of colonies on the Ammer, which were still tended as objects of forestry, or huntsman's craft. An authority, at the close of the last century,§ assigns to them many localities in Germany: as in the Mark, especially in the Altmark and Priegnitz, and in the Middle Mark; and in the rivers Spree and Havel, in the vicinities of Berlin, Potsdam, Oranienberg, Liebenwalde, Trebbin, Nauen, and Königshorst.

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[*] Histoire Naturelle (1760), t. viii., pp. 286, 301.

[†] Règne Animal; Mammiféres, p. 250.

[*] Dictionnaire Classique d'Histoire Naturelle, t. iii., p. 264.

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* Naturgeschichte Deutschlands, B. i., pp. 915, 916.

† Allegemeine Naturgeschichte (1838), B. vii., abth. ii., p. 742.

‡ Lehrbuch der pharmaceutischen Zoologie, p. 15.

§ Krünitz, Oekonomische Encyklop. (Berlin, 1783), B. iv., p. 392.

Even close to the present day, the beaver, though scanty in its relative numbers, has a wider distribution in Europe than is usually imagined. Wagner, writing in 1846, mentions it[*] as still not only in the Danube, but in the Amber, Isar, Iller, and Salzach, tributaries of that river; as well as in the Elbe and Oder; while in other rivers it has only recently disappeared. In Norway, Sweden, and Poland, he reports them as in greater numbers, and as distributed over Russia. Schmarda[†] mentions them as occurring in Transylvania; and Oken says they exist in the Traun in Austria, besides specifying for North Russia the Dwina and Petschora. Blasius[‡] reports that a specimen was taken in Brunswick, in the Schunter, at the close of last century: but that a few years ago they were observed in the Lippe in Westphalia; and that they are still found on the Elbe, between Magdeburg and Wittenberg, though the colonies, since 1848, have been greatly reduced. He adds, that they have been recently observed in the Havel and Oder in the Altmark, in the Vistula, within East Prussia, and in Silesia; and, more abundantly, in Lithuania and Poland, and in North Russia. In North-Western Germany it was found, at least formerly, in the Moselle and the Maas. Chenu[§] mentions it as tolerably abundant in the southern part of the Rhône. They have been killed near Arles, Beaucaire, Tarascon, and even Avignon; and still subsist in such numbers as to elicit his surprise, that some authors should have asserted their extinction in France. Of two which Fr. Cuvier had alive, one was from the Danube, and the other from the Gardon, in Dauphiny. In the Norwegian Pharmacopœia of 1854, the Norwegian castoreum holds its place beside that of Russia and of Canada.[‖] Wylie, in the Russian Military Pharmacopœia,[¶] mentions the animal as common in Russia and Siberia, and more rare in Livonia and Poland.

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[*] Abhandl. der Math. Phys. Classe der k. Bayer. Akad. der Wissenschaften (Munich, 1846); Die geographische Verbreitung der Säugthiere, p. 35.

[†] Die geographische Verbreitung der Thiere (Wien, 1853); II. Abth., p. 232.

[‡] Fauna der Wirbelthiere Deutschlands (1857), p. 407.

[§] Encyc. d'Histoire Naturelle (1854); Rongeurs et Pachydermes, p. 65.

[‖] Pharmacopœa Norvegica, p. 24.

[¶] Pharmacopœia Castrensis Ruthenica (1840), p. 79.

In South Russia, Demidoff[*] says that they are somewhat scarce on the Danube, but that they are more common in the region towards the Caucasus, and that many have been recently killed in the districts watered by the Natanebi and the Tereck. To the river habitats already noted, Moleschott adds[†] the Inn, the Lech, the Upper Rhine, the Weser, and the Bug, as each still presenting rare examples. Upon the whole, the beaver still appears to be encountered, seldom or never plentifully, always in greatly diminished numbers, and generally with an extreme and constantly increasing rarity, in the Austrian and Prussian States, Bavaria, Russia, Sweden, Norway, Lapland, France, and perhaps Switzerland. Among countries, again, in which we have proofs that it was formerly known, it has become extinct in England and Scotland, in Italy, Spain, Denmark, the Netherlands, and many tracts of Germany.

While it is natural that an animal of the magnitude of the beaver, offering various temptations by its spoils, and provoking destruction on the part of the forester by its devastations, should give way before the extension of a population which has intruded besides on the privacy it loved for its haunts, it has been, nevertheless, not without some efforts for its preservation and retention that it has gradually receded before the presence of man. Like other objects of the chase, it was held, from a very early period, as a *regale;* and an officer called the *Beverarius*,[‡] appointed for its cognizance, was among the retinue of the palace of the Frankish Sovereigns. It was pursued with all the usual appliances of spear, net, and hound.[§] In the laws of the Bavarians, of the time of King Dagobert I., or the beginning of the seventh century, we find a fine of six solidi imposed upon whomsoever should kill the dog, "quem *bibarhunt* vocant,"[||] along with the restitution of a similar animal. This *beaver-hound* still appears in the best and most recent Swedish Dictionary, that of Dalin, as the

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[*] Voyage dans la Russie Méridionale (1840), t. iii., p. 26.

[†] Physiologie der Voedingsmiddelen (Amst., 1850), p. 238.

[‡] Du Cange, Gloss. Med. et Inf. Latin; V. Beverarii.

[§] Georgica Curiosa, t. ii., p. 461.

[||] Lindenbrog, Codex Legum Antiquarum; Lex Baivvariorum, tit. xix., §. 4.

"*bäfverhund*," "a dog trained for the chace of the beaver," though probably few are now thus exercised; while possibly, with the ancient Greeks, the *καστόριαι*, considered by Xenophon to have been thus named from the Castor of mythology, were dogs reared for a like purpose. In a German charter, dated in 1103, the right of hunting beavers is conferred along with other huntings and fishings; and a Bull of Pope Lucius III., in the year 1182, bestows upon a monastery the property in the beavers within their bounds. In comparatively recent times, Mylius cites a Prussian royal edict, regarding the beaver in the Elbe, dated 20th January 1714; with a subsequent one, insisting upon its protection under a penalty of no less than 200 dollars, issued at Berlin on the 24th March 1725. It was doubtless under a similar policy, that Frederick II. is reported to have gathered together a large colony of beavers, that he might turn them to economic uses: but with so little success, says Zimmermann,* that they became afterwards dispersed throughout Brandenburg, and were soon rarely encountered.

Among the uses to which the beaver was applied, we have seen that its flesh was employed as an article of diet. Streso, a Dutch writer, states† that the animal was used as food in Holland, in the time of the Crusades; and he repeats the common notice, that its tail and paws were eaten as fish, with a safe conscience, during the religious fasts. But the monks of a convent of Chartreux, at Villeneuve-les-Avignon, seem to have carried this indulgent notion farther, and to have accounted their entire carcass among the "*mets maigres;*" preparing from it large quantities of sausages, which were sold, and highly prized, in the adjoining country. Albertus Magnus, however, says‡ that their whole flesh was abominable, except the tail. Gesner§ describes the mode in which it was rendered savoury by the Swiss, he himself relishing the choicer portions as sweet and tender, "jure croceo conditos." Belon also tells us[*] that its tail, which, he says, sometimes weighs 4 lb., was in his day used in Lorraine during Lent, and accounted a great delicacy, having a close resemblance in flavour to a nicely-dressed eel. The northern nations, according to Olaus Magnus,[†] agreed with the rest in considering the tail and paws as highly delicate morsels. Archæology finds everywhere the elucidation of its researches, and nowhere more naturally meets an illustration of the diet of the primitive people of the North than in their old kitchen heaps, which have lately attracted attention in Denmark. In these, among the shells of oysters, and other edible fish, the split bones of animals, stone implements, and layers of ashes, have been found the relics of the now extinct beaver and urox.[‡] Professor A. Retzius communicates to the Swedish Royal Academy of Sciences[§] a similar notice, relative to several of these kitchen heaps observed for the first time on the coast of Sweden, where it is said, though without specifying the beaver, that the fragmentary bones bore the greatest resemblance to those found in Denmark; while the shells were chiefly those of *Tritonium antiquum* and *undatum*, still abundant in the neighbouring sea, with, here and there, *Cyprina islandica*. There is an analogous heap of shells which I have seen near the monastery of Holy Island, the site of the ancient foundation of the see, and afterwards an appendage of the Benedictine Abbey, of Durham, a complete examination of which might contribute something to repay the attention of a native antiquary.

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* Specimen Zoologiæ Geographicæ (1777), p. 297.

† Over de Levenswijze en Gewoonten onser voorvaderen (Haarlem, 1814), p. 69.

‡ Opera Universa, tom. vi., p. 584.

§ De Quadrupedibus, lib. i., p. 339.

The skin of the beaver, we know, has been long prized in Europe as a fur, and applied to various purposes in dress and manufacture. It is an early notice of this description which we find in Herodotus,[‖] who tells us that the Budini employed it as a trimming to their cloaks. Beckman[¶] cites several instances of its use in the earlier portions of the Christian era. We have seen the peculiar value which was attached to it in Wales, in the time of Hywel Dda; but this value, like that of other objects of fashion, appears to have been fluctuating. Adam of Bremen, in the eleventh century, reckons the "pelles castorum" among the objects of vanity, the admiration of which crazed his cotemporaries: but Albertus Magnus,* in the thirteenth century, says that they were formerly precious, yet were then of little value; while Olaus Magnus, so recently as the sixteenth, states that they were esteemed as "vestitus satis preciosus"† among the Northern magnates. Belon mentions‡ that his countrymen were accustomed to make cloaks and gloves of the fur against the inclemency of the weather; and Boece we have already quoted as reporting that it was sought in this country by foreigners, at a great cost. Even now, a beaver skin of the finer description, from Kamtschatka, is said to sell in Russia‖ for from 100 to 150 rubles: yet in England, in 1836, the price of the skin of the old beaver, from Canada, at the Hudson Bay Company's sales, was only L.1, 12s. 6d.; and three years later we notice that 26 skins were imported hither from the north of Europe, independent of the American supply. During later centuries, the chief interest in the fur of the beaver lay in its employment for the manufacture of beaver hats, now also disappearing from among us. At what time these were first introduced into England appears doubtful. The process of felting has itself been judged more ancient than that of weaving, and seems to have been originally introduced from Asia into Europe, where it was known, even in the time of Homer and of Hesiod, as applied to the formation of coverings for the head. Nor was the process forgotten or disused during the middle ages. The Anglo-Saxon Glossary of Archbishop Ælfric gives *felt* as *lana coactilis.* A Bull of Gregory IX., or prior to the middle of the thirteenth century, speaks of hats made "ex filtris, et coactis lanis." A "chapel de bièvre," therefore, for the king of France in 1351, mentioned by Du Cange,* may have been, and, I suspect from the context, really was, a hat felted from the fur of the beaver. Bruyerin, who probably wrote before 1530, and certainly not more than thirty years later, states that the Germans made hats from this fur, "quos, inversis literis, *bifros* pro *fibros* appellitant."† The method of felting was now probably greatly improved. Yet beaver hats do not appear to have been made in England up to the close of the sixteenth century; for, in Stubbe's curious "Anatomie of Abuses," published in 1583, we find them still noticed as a foreign importation: "And as the fashions," he says, "bee rare and straunge, so is the stuffe whereof their hattes be made divers also; for some are of silke, some of velvet, some of taffetie, some of wooll, and, which is more curious, some of a certaine kinde of fine haire; these they call bever hats, of xx, xxx, or xl shillinges price, fetched from beyonde the seas, from whence a great sorte of other vanities doe come besides." Pennant‡ assigns to the time of Charles I. the commencement of their ordinary manufacture in this country. As it was now, however, the fur of the American animal which was all but universally and necessarily adopted, the interest, as connected with the scope of these notes, naturally ceases. Still, it may be worth mentioning that, superseded as it is of late in the making of hats, the skin of the beaver, notwithstanding its increasing scarcity, would have sunk to even a lower than its present value, had it not been that a new process has been contrived in which the surface is cut by an ingenious machine, with the result of producing a fur of a higher beauty, exported to various parts of Europe and the East. The rich white wool, it may be added, from the under part of the beaver, seems still to find a ready market in France.

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[*] De Aquatilibus, p. 28.

[†] Historia de Gentibus Septentrionalibus, lib. xviii., cap. v., p. 604.

[‡] Worsaa, Beretning om de paa de danske Kyster forefundne saakaldte Kjökkenmöddinger (Naturförskermödet i Christiania, 1856); Illustreret Nyhedsblad, B. iv., p. 116.

[§] Öfversigt af Kongl. Vetenskaps-Akad. Förhandlingar, Tolfte Årgången (Stockholm, 1856), pp. 231–2.

[‖] Historia; Melpomene iv., § 109.

[¶] History of Inventions, vol. ii. (ed. iv.), p. 318.

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* Opera Universa, tom. vi., p. 584.

† Hist. de Gent. Sept., lib. xviii., cap. 6.

‡ De Aquatilibus, p. 28.

§ Klemm, Die menschliche Kleidung, Culturgeschichtliche Skizze (1854), p. 7.

The attention which the history of the European beaver demands from the physician, when considered with reference to its economic and hygienic uses, whether as producing an article of diet in its flesh, or of clothing in its fur, is of course widely subordinate to that which belongs to it as the source of various remedial applications, and, above all, of the for long greatly esteemed castoreum. The fable of Æsop, we have seen, already instructs us that, in the sixth century before Christ, or twenty-four hundred years ago, the beaver was recognised as an object of quest on the score of this drug. Herodotus also, not long after, tells us that it was used by the Budini in uterine diseases. We are prepared, then, from these merely popular notices, to find that Hippocrates, the cotemporary of Herodotus, introduces, though chiefly in treatises that are of questionable authenticity,* the recommendation of its employment, as if of a substance already familar, in the same class of diseases. Its appearance, subsequently, in the exclusively literary writings of several of the eminent authors of antiquity, shows that it continued extensively enough known to give scope and propriety to the use, as an illustration, of the extravagant tradition as to the circumstances of its acquisition. Pliny presents us with a detailed account of the value and extent of its uses in medicine; nor is it difficult to recognise afterwards, through all the middle ages, the special impress of the testimony of the Roman naturalist, or of the sources from which he derived it. The castoreum, according to Pliny,† externally used acted as an errhine, or, rubbed upon the head, induced sleep. Taken internally, and usually in doses of two drachms, it was beneficial in mania, in epilepsy, in amenorrhœa, and against multiform descriptions of poison. Whether used externally or internally, it was serviceable in vertigo, tetanus, tremors, spasms, nervous complaints, sciatica, dyspepsia, hiccup, and palsy. Adapted as a fumigation, it removed lethargy; as a suppository, or medicated pessary, it was beneficial in affections of the uterus; as a collyrium, it gave clearness to the eye-sight; and mixed with oil, and dropped into the ear, it cured aches in that organ and in the teeth. Dioscorides‡ recommends the castoreum as facilitating childbirth; and this appears also among its accredited virtues in many subsequent writers. We need only add, with reference to the writers of the classical period, that with Celsus* it also ranked as an approved remedy; that Aretæus† bestowed upon it his confidence, especially in nervous diseases; and that Galen‡ styles it a celebrated medicine, and much in use, so that, he continues, Archigenes wrote a whole book regarding it. This weight of authority, and chiefly that of Galen, whose great genius, as well as admirable ingenuity and boldness of hypothetical statement, is so well known to have long kept the world of medicine at his feet, was as fitted to maintain for the castoreum its credit in the science of the times, as to secure its transmission to an unchallenged place in the art of the middle ages.

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* Glossar. Med. et Inf. Latin; V. Capellus.

† De re cibaria, lib. xiii., cap. 32.

‡ Arctic Zoology, vol. i., p. 104.

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* Opera Omnia (ed. Foes.): De superfœtatione, sect. iii., p. 47; De Natura Muliebri, sect. v., p. 136.

† Historia Naturalis, lib. xxxii., cap. iii.

‡ De Materia Medica, lib. iii., cap. xxvi.

To trace carefully the progress of a remedy so extensively employed, and so highly lauded in a wide range of diseases, through all the darker ages of learning, down to its revival, and so onwards to the present day, would be a needless, though not an uninteresting, or even altogether an unprofitable task. With only a little ingenuity, such a history might be rendered that of the human intelligence in relation to medicine: and as hypothesis thrust away hypothesis, and superstition trod on the heels of superstition; or as men bent themselves before the influence of authority, and credulity usurped the place of inquiry, standing, as it ever stands, more boldly on its assumptions than reason on its proofs, we see the rarely unprominent remedy adapting itself to every phase of opinion, and still intertwining itself firmly with medical practice, now under one explanation of its qualities, and now under another, until better methods of induction and inference assigned to it finally a truer, if not yet a wholly fixed position, among our therapeutic resources. Ushered in under the auspices we have recorded, the appreciation of the high efficacy of castoreum received a new impulse in Europe, in and after the eleventh century, through the diffusion of the writings of Avicenna. The Persian Galen recommended it in a wide range of morbid conditions; but, through the Eastern haze of his phraseology, with a less distinct and precise application to individual ailments than occurs in the older writers, and especially in Pliny. Following and intensifying the peculiar views and modes of expression of Galen, he tells us,[*] that, while the medicine was warm at the end of the third, and up to the fourth or highest degree, it was dry in the second, and hence he deduces the fitting occasions for its employment. Notices of its importance continue to appear everywhere in subsequent writers. Albertus Magnus, in the treatise already quoted, repeats that it was given in large doses, to facilitate childbirth. Our countryman, John of Gaddesden,[†] was familiar with its use, especially in the diseases of women. Cardan,[‡] with all the gigantic faith of our predecessors, assigns an authority for stating that the genuine drug, which, however, was rarely seen, because of the avarice of the traders, was so subtle and powerful in odour when fresh, that it produced epistaxis in four men who smelled it successively. With a like spirit, Baptista Porta, in the singular treatise in which he demonstrates, from outward inspection, the hidden qualities of things,[§] gravely assures us, that it is because the castor-sac has a somewhat large head, that the castoreum, when rubbed in, relieves headache; while in another passage[‖] we learn as rationally, that, as the beaver wanders abroad at night, we have hence an obvious explanation of the great use of the drug in obscurity of vision. Among other medical uses with his northern countrymen, Olaus Magnus records that of its relieving the sufferings of labour, when taken to the bulk of a walnut, mixed with ale.

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* De Re Medica, lib. iii., cap. xx. xxiii. xxiv.

† Opera Omnia; De Curatione Acutorum Morborum, lib. i., cap. ii.

‡ Opera Omnia; De Simple. Medic. Temperamentis ac Facultatibus, lib. xi., cap i., § 15.

But it is in the treatise of Marius,[¶] as published and augmented by Francus,[**] to which I refer as it is embodied in the ponderous compilation of Manget,[††] that we find the fullest record of the uses in medicine of the various spoils of the beaver. Besides the diseases we have mentioned as benefited by its virtues, according to the testimony of the ancient writers, these German authors name gastralgia, dysentery, worms, retention of urine, induration of liver and spleen, pleurisy, with other pectoral complaints, gout, hysteria, hemicrania, and loss of memory, in which last it acted "stupenda cum admiratione." But it had virtues even beyond these; and was potent, for example, in destroying vermin, after a fashion in which it might now be difficult to find the opportunities for displaying its qualities: "Certe," says Marius, speaking of the castoreum of his own district, "multa pediculorum millia castoreo nostro enecavi." And it was not the castoreum only that was thus widely serviceable, but the animal, in all its parts, seems to have ranked with our predecessors as a complete armoury of physic. Its oil, an unctuous matter found in the two smaller follicles contiguous to the castor-sacs, when applied warm, cured lethargy, apoplexy, spasm, and convulsions; gave freedom and strength of action to rigid tendons; relieved hysteralgia, nephralgia, and rheumatism; and was of wonderful efficacy in vertigo, toothache, asthma, nausea, vomiting, colic, tenesmus, and dysentery. Its tail, as food, to revert for an instant to the authority of Olaus Magnus, was valuable for its healing quality in wounds of the intestines. The blood, too, was beneficial in epilepsy: and the teeth, hung from the neck, promoted dentition; or, in adults, as Jonston* informs us, served as an amulet to preserve from casualties. The gall, we learn from Rondelet,† cured affections of the eyes; and the fur arrested epistaxis and hæmorrhage from wounds, of course after the fashion of any other flossy material: an old reputation which has retained its recent traces, no recourse having been more familiar, even in our own day, so long as beaver hats were customarily worn, than to scrape a little down from their inner surface, and apply it to stop bleeding from a leech-bite or a superficial incision. The skin, besides, made into slippers, stockings, and gloves, was advantageously worn by the gouty; and, when newly stripped from the animal, and still retaining its natural heat, as our authorities could find opportunities of employing it, its application was judged most serviceable in colic and hysteralgia, and even in mania. In a case of the latter, seen by Marius in Wirtemberg, the fresh skin was thus applied to the shaven scalp: a remedy under which it is gratefully acknowledged that amendment, through the Divine favour, gradually ensued. Adapted to the ailing part, a similar application was also excellent in spasm, weakness of stomach, atrophy of children, and in bed-sores. Further, the worthy Johannes Marius certainly does not avouch, but neither does he reject, what he had heard from a Jew, as no less than a tradition from King Solomon, that to wear a beaver hat, rub the head and spine with oil of castoreum, and swallow the weight of a gold piece of its substance twice a-year, made the memory so retentive that it lost nothing. When it is added, that even this copious summary does not exhaust the catalogue of ailments for which the beaver is thus held to provide a trustworthy remedy, and that the averments are all sustained by an accumulation of illustrative cases, extending over more than twenty folio pages, we can readily conceive what must have been the importance of the subject in the estimation of the older physicians; to the generality of whom the praises of Marius and Francus, whose treatise was in unquestionable repute, were nothing more than the expression of a prevailing conviction. So believing, well might our Quincy* say of castoreum: "Certainly it is a most noble drug."

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[*] Canon Medicinæ, lib. ii., cap. 125.

[†] Rosa Anglica (1492), car. 103.

[‡] De Subtilitate; lib. x. (De Animalib. perfect.), p. 414.

[§] Phytognomonia, lib. iii., cap. xxxviii.

[‖] Ibid., lib. v., cap. xxvi.

[¶] Johann Mayer practised in Ulm and Augsburg, and died in the latter city in 1644.

[**] Johann Francke, who died at Ulm in 1728. The "Castorologia" was published in 1685.

[††] Bibliotheca Pharmaceutico-Medica (1703), tom. i., p. 489.

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* **Historia Naturalis : lib. i., De Quadrupedibus (1657), p. 104.**

† **De Amphibiis, cap. viii.**

Gradually during the last century, yet slowly, and in few countries entirely, the reputation of the castoreum as a remedy has been declining throughout Europe. Still, in every national pharmacopœia, and in most of the approved formularies constructed by individual skill, it continues to hold its place. If, in this country, it has recently fallen into almost complete discredit or neglect, and, in the United States also, practitioners, as we are informed,† rarely resort to it, in France it still retains at least a portion of its former reputation. H. Cloquet, at a late period, has spoken of it‡ as a medicine actually in use among many distinguished practitioners, and chiefly in convulsions, palpitation of the heart, hiccup, hysteria, hypochondriasis, and asthma; and he further avouches its possessing considerable virtues as an emmenagogue. He assigns its dose as from ten grains to two drachms or more, given once or several times daily; and he considers its powers actively stimulant, with a special faculty of modifying the actions of the nervous system, through which it ranks as an antispasmodic. He cites the experience of Thouvenel, on his own person, that in quantities of one or two drachms it gives frequency and development to the pulse, and stimulates the vital forces; but this we may contrast with what we learn elsewhere from Professor Jörg, who maintained that, even in the larger of these doses, it produced no other effect than troublesome eructations. Jourdan,* still more recently, refers to it as greatly used in hysteria and hypochondriasis. In Germany, Geiger and Marquart,† like the other continental authorities, remark the superiority of the European, and especially of the Russian and Bavarian, castoreum over that from America, which has been for long that in ordinary use in this country; and certainly the analysis of Brandes, in his *Archiv für die Pharmacie*, showing a double quantity of ethereal oil, and a quadruple quantity of castoreum-resinoid in the former, with a twenty-fold quantity of earthy carbonates in the latter, points, with other disparities, to a very remarkable difference, which ought not to escape consideration anywhere inestimating the efficacy of the drug. Dulk‡ mentions it as highly prized in hysteria; and Martius speaks of its being still a remedy in frequent employment, but costly, and thence liable to adulteration, as we know that it was of old, in the time of Pliny and Dioscorides. Indeed, nothing proves more convincingly the pertinacity with which the European castoreum still retains its reputation, in some quarters, than the extravagance of its price; as there is scarcely anything more certain to give a plea for the rapid curtailment of its use, even before the approaching extinction of the animal has removed the remedy wholly and conclusively from its long-inherited position in the practice of medicine.

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* Compleat Dispensatory (1718), p. 93.

† United States Dispensatory, *v.* Castoreum.

‡ Dictionnaire de Médecine, t. iv., p. 341.

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* Pharmacopée Universelle (ed. ii.), t. i., p. 476.

† Pharmaceutische Zoologie (Zweite Auflage), p. 279.

‡ Die Preussische Pharmakopöe übersetzt und erläutert, p. 9.

§ Lehrbuch der Pharmaceutischen Zoologie, pp. 18, 19.

Dörrffurt, writing in 1801,* describes the European variety, with the exception of the Swedish which seems generally less prized, as valued by the German apothecaries at from twelve to sixteen times the cost of that from Canada. But we find a better indication of what is its actual value in Austria, in a notice before the Imperial Society of Physicians of Vienna,† of an animal recently captured in Transylvania, whose castoreum-pouch weighed 7¼ oz.,‡ and was bought by Herr Haubner, the druggist who exhibited it on the occasion, for no less a sum than 362 florins, or L.36 sterling. The castoreum, we learn from the same authority, is sold in the Austrian capital at 45 kreuzers, or 1s. 6d. per grain; which would give L.261 as the proceeds of this individual pouch. To prescribe it in two-drachm doses, therefore, thrice a-day, would entail a charge upon the patient of L.27 sterling daily; or, in other words, the full use of the remedy, as formerly exhibited, becomes an impossibility, unless where there coincides a wealth and a reliance which can be only rarely encountered: and it can be no wonder that Professor Pleischl recommends the promotion and maintenance in the Danube of the breed of an animal, thus at once evinced to be so rare, and producing so precious a material. As a proof how vastly the cost of the drug has been enhanced in Austria, since the close of the last century, we refer to the authorized price-list,§ issued for the provinces in 1795, where we find the Russian, or reputed best quality, rated at 2 fl. 40 kr. the *loth*, or half-ounce; or at equivalent to little more than a farthing per grain. In a similar price-list, lately authorized for Norway,‖ the native castoreum, according as it is sold crude or powdered, is rated at a price equal to from 6½d. to 9d. a grain; but the Canadian at only from 14d. to 1s. 6d. per drachm, or at a little under and above a farthing a grain: while in the national pharmacopœia* it is directed that the Canadian variety only shall be dispensed, unless the Norwegian or Russian be expressly demanded. The price in this country has a comparatively slight relation to our subject, because, doubtless, here the Canadian castoreum has alone been customarily used. We have, however, an early notice regarding it. In Gordon's curious "Pharmaco-Pinax, or Table and Taxe of the Pryces of all usuall Medicaments, Aberdene, 1625," the castoreum of the "Bedgar, or Beaver Cod," is rated at 4s. a drachm, the prices being "redacted to the lowest of this yeare," and, we conclude, in Scots currency. Our most eminent firm of druggists in this city inform me, that castoreum is still occasionally, but only rarely, required in prescriptions, and exclusively as tincture; and that it is especially within the last quarter of a century that it has glided out of employment. This is consistent with my own more limited opportunities of observation, and accords with the estimate expressed regarding it by the late Dr Duncan junior,† who, in 1822, characterizes it as an excellent antispasmodic, and as given with advantage in typhoid fevers, in spasmodic complaints, and in amenorrhæa. Its retail price may now be stated at about 9d. per drachm. The *axungia castorei*, or oily matter from the smaller follicles, seems now to be nowhere in request, unless it be in Sweden, where Nilsson, in his *Scandinavisk Fauna*, mentions that it is used in rheumatism, and that it is as costly as the castoreum.

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* Deutsche Apothekerkunst, Theil i., p. 122.

† Wochenblatt der Zeitschrift der k. k. Gesellschaft der Aerzte zu Wien (1857), p. 126.

‡ The Bavarian castor-pouch has been known to be double this weight, but many weigh only from three to five ounces. Buchner mentions a pair from the Danube which weighed 31 oz. when half dried.

§ Taxa Medicament. in Pharm. Austriaco-Provinciali (1795), p. 9.

‖ Medicinal-Taxt for Norge, gjældende fra 1ste Januar 1856 indtil videre, p. 9.

These notes are not designed as therapeutical, or as natural-historical, but are simply historical. It is not, therefore, necessary, on the one hand, to enter into any discussion as to the proper position and value of castoreum as a remedy, or to attempt, testing it by modern views, to determine whether, in this country, it may not be as unjustly undervalued now as it was unquestionably over-estimated before. It cannot be merely as a matter derived from the animal kingdom that it has fallen into disrepute, as if through a reflexion of the discredit brought upon this class of remedies by the many instances otherwise of the mingled credulity and grossness of our predecessors; because we possess too many proofs of the singular power over the living system of matters so derived, to permit us to question their energy, whether for good or for evil; and none of a more admirable nature, though with no pretence of suggestion of an analogy, than that by which the vaccine virus not only produces a directly resulting effect upon the constitution, but more or less enduringly modifies its susceptibilities afterwards. I am aware, on the other hand, that, with the demonstration of an identity of habits between the beavers of the Old and the New Continents, the question of an identity of species is not definitively settled: and that several writers, among whom are Neill, Frederic Cuvier, Owen, and especially, and with the largest opportunities of observation, Brandt,* have sought, more or less determinately, to establish a more certain distinction between them; the differences marked having been chiefly of a craniological description, and resting principally on the evidently greater breadth, in the fossil and European specimens, of the intermaxillary bones and of the fore-teeth; on the further extension backwards of the nasal bones; and on the larger cavity in the basilar process of the occipital bone, a depression there for containing a peculiar sac designed to furnish a secretion for the lubrication of the pharynx. Other naturalists, again, incline to the view of a complete identity, or, at the most, of only a variation, and not a specific difference between them. It may be merely permitted to remark, that these craniological distinctions, which hold good in as far as my limited opportunities have permitted me to examine them, may be, nevertheless, truly dependent on the gradually developed force of a single accidental circumstance, or form of acclimatization, rather than upon any originally specific and essential difference. Thus, if we assign, as we justifiably may, a denser woody texture to those trees of Europe which constitute the habitual food or material for building of the beaver, than to their congeners in America, we have, along with the demand for a more abundant lubricating fluid to promote deglutition, the necessity for an adaptation of stronger incisors for their division, and hence for an expansion of the intermaxillaries for the reception of these, with the consequent interposition of a greater space between the maxillaries, to be filled up by larger ossa nasi. These questions, however, I merely indicate, but without desiring to encroach upon their nearer investigation. My object has been, keeping mainly in view the relations of the European beaver to hygienics and medicine, to trace comprehensively and broadly its history as it was, and not as it might be regarded with reference to others.

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* Pharmacopœa norvegica (Christiania, 1854), p. 24.

† Edinburgh New Dispensatory (1822), p. 91.

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* Beiträge zur nähern Kentniss der Gattung Castor: Mém. de l'Acad. Imp. des Sciences de Saint-Peterbourg; Sciences Naturelles, tome vii. (1855), p. 45.

Probably it may be considered that I have devoted an attention to this subject beyond what its importance warranted. Yet such subjects may be easily constituted, by those who do not choose to narrow their life to its own term, into real landmarks in the domain of knowledge: or rather, they furnish successions of epochs in the history of science and civilization, around which gather and assimilate more or less closely, not only the ideas and dogmas, but even the social conditions of the time; and thus they convey lessons, more important than may at first appear, both as to what was and what is. A cursory reader may find merely interesting, while another will consider tedious, the details which I have eliminated, condensed, and grouped from not a few far apart fields of literature; a process which I have striven to render accurate, and during which I have occasionally found opportunity of silently making use of one authority to correct an error rendered current by another. To those whom a natural suggestiveness leads to penetrate more deeply, they will have, were it only on this score, a still higher value. A record, thus apparently closing after a lapse of more than twenty-four centuries, may well invite us to consider, which of our matters of faith in doctrine or reputation, unquestionable as has been our general progress, is more firmly grounded, or likely to have as lasting an endurance:

> "—— quum rupta situ Messalæ saxa jacebunt,
> Altaque quum Licini marmora pulvis erunt."

Theory of Linear Vibration—(continued). By EDWARD SANG, Esq., F.R.S.E.

IV.—*Uniform Linear Series.*

When the bodies A, B, C . . . K, L, M are all of equal weight, and the elasticities of the springs are all alike, the formulæ become more simple, and the roots of the equations are easily found. Putting w for the common weight, and e for the coefficient of elasticity of the connecting springs, equations (37) take the form

$$
\begin{aligned}
{}_{2t}x_{A} &= \frac{e}{w}\left\{ x_{A} - 2x_{A} + x_{B} \right\} \\
{}_{2t}x_{B} &= \frac{e}{w}\left\{ x_{A} - 2x_{B} + x_{C} \right\} \\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\
{}_{2t}x_{L} &= \frac{e}{w}\left\{ x_{K} - 2x_{L} + x_{M} \right\} \\
{}_{2t}x_{M} &= \frac{e}{w}\left\{ x_{L} - 2x_{M} + x_{M} \right\} \quad . \quad . \quad . \quad . \qquad (48.)
\end{aligned}
$$

Assuming, as we have seen to be allowable in all elastic systems, that one of the simple vibrations of which the system is capable, is indicated by the formula

$$x_{A} = a\mathrm{U}\sin(\theta t + u)\,;\ x_{B} = b\mathrm{U}\sin(\theta t + u)\,;\ \&c. \quad . \quad . \quad . \qquad (49.)$$

inserting these values of x_{A}, x_{B}, &c., in the preceding equations, dividing all by $\mathrm{U}\sin(\theta t + u)$, and arranging, we obtain

$$
\begin{aligned}
&(2 - \tfrac{w}{e}\theta^2)\, a - a = b, \\
&(2 - \tfrac{w}{e}\theta^2)\, b - a = c, \\
&(2 - \tfrac{w}{e}\theta^2)\, c - b = d, \\
&\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\
&(2 - \tfrac{w}{e}\theta^2)\, l - k = m, \\
&(2 - \tfrac{w}{e}\theta^2) m - l = m, \qquad . \quad . \quad . \qquad (52.)
\end{aligned}
$$

and therefore the series of quantities $a, b, c, \ldots k, l, m$, form a Brounckerian progression, of which the scale is represented by $(2 - \frac{w}{e}\theta^2)$ and (-1). Putting, for the sake of shortness, $2 - \frac{w}{s}\theta^2 = s$, and assuming the first term of the progression as unit, we have

$$\begin{aligned}
a &= 1 \\
\alpha &= 1 \\
b &= s - 1 \\
c &= s^2 - s - 1 \\
d &= s^3 - s^2 - 2s + 1 \\
e &= s^4 - s^3 - 3s^2 + 2s + 1 \\
f &= s^5 - s^4 - 4s^3 + 3s^2 + 3s - 1 \\
g &= s^6 - s^5 - 5s^4 + 4s^3 + 6s^2 - 3s - 1 \\
&\text{\&c.} \qquad \text{\&c.} \qquad \text{\&c.}
\end{aligned}$$

And, in order to find the value of s, for a series consisting of any given number of bodies, we must equate two of the values thus found. For example, if the series consist of the six equal bodies A, B, C, D, E, F, the above value of g must be equal to that of f; or $g - f = 0$. The series of equations, then, which express the conditions of vibration of systems consisting of *two*, *three*, *four*, &c., bodies, are,

$$\begin{array}{lll}
\text{Two bodies,} & c - b = 0 \text{ or } s^2 - 2s & = 0 \\
\text{Three bodies,} & d - c = 0 \text{ or } s^3 - 2s^2 - s + 2 & = 0 \\
\text{Four bodies,} & e - d = 0 \text{ or } s^4 - 2s^3 - 2s^2 + 4s & = 0 \\
\text{\&c.} & \text{\&c.} & \text{\&c.} \quad . \quad . \quad (53.)
\end{array}$$

Now, since the quantities a, b, c, &c., are in a Brounckerian progression with a uniform scale, their differences must also form a series of the same kind. But the two first terms of this series are divisible by $s - 2$, therefore every succeeding term must be divisible by the same. That is to say, $s = 2$ is a universal root of all these equations. This root corresponds to $\theta = 0$, and merely represents the uniform rectilineal motion of the system, when there is no internal disturbance of the relative positions. Those conditions which bear upon our present inquiry are obtained by dividing all by $s-2$, and are

For two bodies, $0=s$
For three bodies, $0=s^2-1$
For four bodies, $0=s^3-2s$
For five bodies, $0=s^4-3s^2+1$
For six bodies, $0=s^5-4s^3+3s$
For seven bodies, $0=s^6-5s^6+6s^2-1$
&c. &c. &c. . . . (54.)

which are at once recognised as belonging to the subdivision of the circle.

If, indeed, we assume

$$s=(2-\frac{w}{e}\theta^2)=2\cos 2\varphi \quad . \quad . \quad . \quad . \quad (55.)$$

and put for a moment $a=\cos\alpha$, we have

$$\begin{aligned} b&=\cos(\alpha+2\varphi)\\ c&=\cos(\alpha+4\varphi)\\ d&=\cos(\alpha+6\varphi),\ \&c.\,; \end{aligned}$$

and going backwards

$$\begin{aligned} a&=\cos a\\ a'&=\cos(\alpha-2\varphi)\,; \end{aligned}$$

wherefore, since $a=a'$, we have $\alpha=\varphi$ and

$$\begin{aligned} a&=\cos\varphi\\ b&=\cos 3\varphi\\ c&=\cos 5\varphi\\ &.\quad.\quad.\quad.\quad.\quad.\\ &.\quad.\quad.\quad.\quad.\quad.\\ k&=\cos(2n-5)\,\varphi\\ l&=\cos(2n-3)\,\varphi\\ m&=\cos(2n-1)\,\varphi\\ m'&=\cos(2n+1)\,\varphi. \quad . \quad . \quad . \quad . \quad . \quad (56.) \end{aligned}$$

Wherefore, since the condition of free vibration requires that $m=m'$, we must have

$$\cos(2n-1)\,\varphi=\cos(2n+1)\,\varphi \quad . \quad . \quad . \quad (57.)$$

an equation which can only be satisfied when $2n\varphi$ is π' or a multiple of π. Hence, in general,

$$2\varphi = \nu \frac{\pi}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (58.)$$

in which ν may be any integer number less than n; and therefore

$$\begin{aligned} a_\nu &= \cos \frac{\nu\pi}{n} \\ b_\nu &= \cos 3 \frac{\nu\pi}{n} \\ c_\nu &= \cos 5 \frac{\nu\pi}{n} \\ &\text{\&c.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (59.) \end{aligned}$$

Also, since $s = 2 - \frac{w}{e}\theta^2 = 2 \cos 2\varphi$

$$\theta = 2\sqrt{\frac{e}{w}} \, . \, \sin \frac{\nu\pi}{2n}$$

and thus the following equations,—

$$\begin{aligned} x_A &= \Sigma \left\{ U_\nu \cos \frac{\nu\pi}{2n} \, . \, \sin \left\{ 2t\sqrt{\frac{e}{w}} \, . \, \sin \frac{\nu\pi}{2n} + u_\nu \right\} \right\} \\ x_B &= \Sigma \left\{ U_\nu \cos 3 \frac{\nu\pi}{2n} \, . \, \sin \left\{ 2t\sqrt{\frac{e}{w}} \, . \, \sin \frac{\nu\pi}{2n} + u_\nu \right\} \right\} \\ x_C &= \Sigma \left\{ U_\nu \cos 5 \frac{\nu\pi}{2n} \, . \, \sin \left\{ 2t\sqrt{\frac{e}{w}} \, . \, \sin \frac{\nu\pi}{2n} + u_\nu \right\} \right\} \\ &\text{\&c.} \qquad \text{\&c.} \qquad \text{\&c.} \quad . \quad . \quad (61.) \end{aligned}$$

contain the expression for every possible vibration of a system consisting of n equal bodies, when their motions are not affected by external causes.

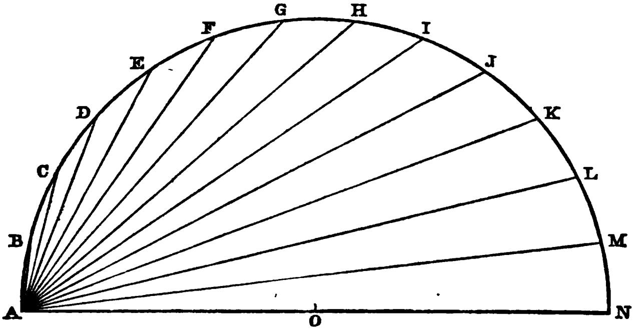
From this it appears, as I asserted in the introduction, that the Newtonian pulsation can only exist in connection with peculiar external influences.

If one of the bodies were attached to an immoveable obstacle through the intervention of one of the springs, it would, when disturbed, vibrate in a certain time, which may be regarded as the period to which all the other vibrations may be referred. In order to compute its duration, we observe that

$$ {}_{2t}x = \frac{e}{w}\left\{ -x \right\}, \qquad \text{whence } x = \mathrm{U}\sin\left(t\sqrt{\frac{e}{w}} + u\right); $$

wherefore the periodic time of this elementary oscillation is $2\pi\sqrt{\frac{e}{w}}$.

Having assumed any line, as OA, to represent the velocity $\sqrt{\frac{e}{w}}$ of this elementary oscillation, describe, with OA as a radius, the semicircle AN, and divide the semicircumference into as many equal parts, AB, BC, CD, &c., as there are bodies in the system, then do the chords AB, AC, AD, &c., represent the rapidities of the various simple vibrations of which the system is capable. The slowest vibration is that which is represented by AB, and the quickest that of which the rapidity is proportional to AM. Now no two of any such chords are commensurable, so that the periodic times of no two vibrations can bear a ratio to each other expressible in numbers, and thus we arrive at the startling statement, that *when a perfectly elastic series of equal bodies is once disturbed, its parts never return to their original state, unless the induced vibration be a simple one;* no conceivable duration of the motions of such a system can, in any other case than that of a simple vibration, reproduce the same phase.



The enunciation of this unexpected proposition naturally leads us to propose the question,—If, in a regular series, the separate vibrations be incommensurable, under what circumstances can those of an irregular series become commensurable?

It has been admitted, rather too hastily, as a truth, that all the notes produced by a sonorous body are in chord with each other: but my analysis of the vibrations of elastic wires showed that the note produced by vibration in the one direction may bear any conceivable ratio to that in the other, so that, while the mechanical effects harmonize completely, so as to produce beautiful curves, the phonetic effect may be utter discord. The proposition above enunciated is another of the same class; but more striking on this account, that the vibrations are absolutely incommensurable.

As an example of the application of the above results, I shall suppose a system of thirteen equal masses, A, B, C, D, E, F, G, H, I, J, K, L, M, connected by springs of equal rigidities; and, for the sake of convenience, I shall suppose that the stiffness of the springs is so adjusted to the weight of the bodies, that when one end of the spring is held fast, the body attached to the other end of it vibrates 100 times in a minute.

The numbers of each of the twelve simple vibrations of which the system is capable, performed in one minute, will then be given by the formula

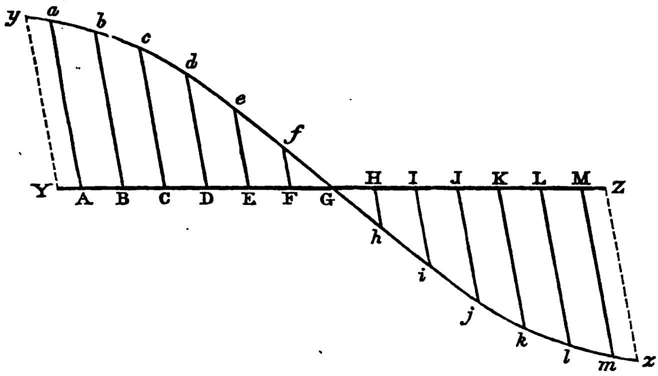
$$200 \sin \frac{\nu\pi}{26},$$

and are, for

AB	24·1072
AC	47·8631
AD	70·9210
AE	92·9446
AF	113·6130
AG	132·6248
AH	149·7022
AI	164·5968
AJ	177·0912
AK	187·0032
AL	194·1884
AM	198·5418

and it is clear that only among the slow vibrations is there any approach to the musical intervals of the *eighth* and the *twelfth*.

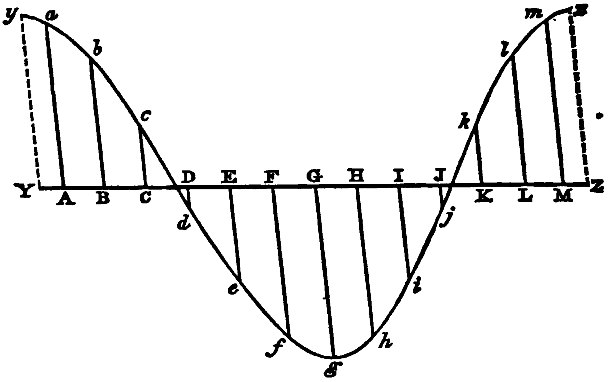
Beginning with the slowest of these vibrations, viz., that represented by AB, we may trace the motions of the several bodies thus: Having laid off twelve equal distances AB, BC, ... LM, along a straight line, measure, beyond A and M at either end, the distance YA and MZ, each equal to half of the common interval, construct on YZ, as a base, the curve



of cosines *yab* . . . . *lmz*, YZ corresponding to the arc π, then the ordinates A*a*, B*b*, ... L*l*, M*m*, are proportional to the extents of vibrations of the respective bodies: and if A*a*, B*b*, ... L*l*, M*m*, were supposed jointed to the line YZ, and to oscillate backwards and forwards on either side of the perpendicular, the motions of the points *a*, *b*, . . . *l*, *m*, would imitate the actual oscillations of the bodies A, B, . . . L, M. Various mechanical arrangements may be made to produce imitations of these motions; one of the simplest is to trace ellipses with varying inclinations upon the surface of a cylinder, and to view these through a narrow slit while the cylinder is revolving. In this oscillation the middle body G remains at rest, while the oscillations of those on either side of it are equal and in opposite directions.

To represent the phenomena of the second vibration, we make YZ the entire base 2π of a curve of cosines; then, as before, the ordinates drawn through the points A, B, . . . L, M, are proportional to the extents of the oscillations of the various bodies.

After these two examples, it is unnecessary to insist on this kind of representation of the simple vibrations of a linear series. It is enough to remark, that, although we can imitate



each of these singly by a mechanical arrangement, we cannot combine any two of them in the motion of a machine. The first of the above vibrations being made at the rate of 24,107 per minute, the second is at the rate of 47,863, and these are strictly incommensurable, so that no train of wheelwork can ever give anything better than a close approximation to the ratio.

The condition of the system at any time, as at the time $t=0$, is known when the position and velocity of each body at that instant are known; wherefore, if (x_A) and (v_A) represent the initial positions and velocities of the body A, we must have

$$(x_A)=\Sigma\left\{\cos\frac{\nu\pi}{2n}\,.\,U_\nu\,.\,\sin u_\nu\right\}$$

$$(v_A)=2\sqrt{\frac{e}{w}}\,.\,\Sigma\left\{\sin\frac{\nu\pi}{2n}\,.\,\cos\frac{\nu\pi}{2n}\,.\,U_\nu\cos u_\nu\right\} \quad (62.)$$

or putting $U_\nu \sin u_\nu=(u_\nu)$, and $U_\nu \cos u_\nu=(u'_\nu)$, for the sake of shortness, we have in detail,

$$(x_A)=(u_1)\cos\frac{\pi}{2n}+(u_2)\cos\frac{2\pi}{2n}+(u_3)\cos\frac{3\pi}{2n}+\&c.$$

$$(x_B)=(u_1)\cos\frac{3\pi}{2n}+(u_2)\cos\frac{6\pi}{2n}+(u_3)\cos\frac{9\pi}{2n}+\&c.$$

$$(x_C)=(u_1)\cos\frac{5\pi}{2n}+(u_2)\cos\frac{10\pi}{2n}+(u_3)\cos\frac{15\pi}{2n}+\&c$$

$$\&c. \qquad \&c. \qquad \&c. \quad . \ . \quad (64.)$$

and

$$(v_A)\,.\,\tfrac{1}{2}\sqrt{\frac{w}{e}}=(u_1')\cos\frac{\pi}{2n}\sin\frac{\pi}{2n}+(u_2')\cos\frac{2\pi}{2n}\sin\frac{2\pi}{2n}+\&c.$$

$$(v_B)\,.\,\tfrac{1}{2}\sqrt{\frac{w}{e}}=(u_1')\cos\frac{3\pi}{2n}\sin\frac{\pi}{2n}+(u_2')\cos\frac{6\pi}{2n}\sin\frac{2\pi}{2n}+\&c.$$

$$(v_C)\,.\,\tfrac{1}{2}\sqrt{\frac{w}{e}}=(u_1')\cos\frac{5\pi}{2n}\sin\frac{\pi}{2n}+(u_2')\cos\frac{10\pi}{2n}\sin\frac{2\pi}{2n}+\&c.$$

$$\&c. \qquad \&c. \qquad \&c. \quad . \ . \quad (65.)$$

These equations of condition are twice as numerous as the bodies in the system, and therefore serve to determine $2n$ unknown quantities, whereas there are only $n-1$ quantities of the forms (u_ν) and (u'_ν)in each set, so that there would appear to be a redundancy of equations. The data, however, include the position and motion of the centre of gravity, which are foreign to our investigations, and therefore the data must satisfy the two conditions

$$\Sigma\left\{\ \mathrm{A}\ (x_A)\ \right\}=0 \qquad \text{and } \Sigma\left\{\ \mathrm{A}\ (v_A)\ \right\}=0$$

which necessarily reduces the number of independent data to $2n-z$; so that the equations (64) and (65) are sufficient, and no more than sufficient, to determine the future motions of the system, when its condition at any one epoch is given.

After having obtained the values of (u_ν) and (u'_ν), those of U_ν and u_ν are readily got, and then the position of any body, say the μ^{th}, in the system will be given by the general formula

$$x_\mu=\Sigma\left\{\cos\frac{\overline{2\mu-1}\,.\,\pi\nu}{2n}\,.\,\mathrm{U}_\nu\sin\left(2\,t\sqrt{\frac{e}{w}}\,.\,\sin\frac{\nu\pi}{2n}+u_\nu\right)\right\}$$

while the velocity of its motion is

$${}_{1\mu}x=2\sqrt{\frac{e}{w}}\Sigma\left\{\cos\frac{\overline{2\mu-1}\,\pi\nu}{2n}\,.\,\sin\frac{\nu\pi}{2n}\,.\,\cos\left(2t\sqrt{\frac{e}{w}}\,.\,\sin\frac{\nu\pi}{2n}+u_\nu\right)\right\}$$

On Herring Fisheries. Translated from Dutch Pamphlets, under the direction of the Board of Trade.*

In the month of March of the year 1856, Dr Buys Ballot, Principal Director of the Royal Meteorologic Institution of the Netherlands, addressed a circular to the owners of the "Great Fishery," in order to invite them, in accordance with the design of Lieutenant N.M. T. Kroef, to induce the herring fishermen to make the necessary observations, and by so doing to give the Institution an opportunity, by collecting and working them out, to ascertain the circumstances likely to lead to the most profitable fishing, as well as to enable them in future, by the possession of observations in different years, to make a herring chart.

The log-book, for which the above-mentioned design served as a basis, was published by the Institution, and, thanks to the energetic endeavours of the Committee of the "Great Fishery" and the different owners, as well as to the praiseworthy zeal of the mates of the herring vessels, the Institution obtained possession of forty-five log-books, kept according to rule, and easy for the Marine Department of this Institution to use for the above-mentioned object.

Lieutenant K. F. R. Andrau, of the said department, was charged with this task, who, in the herring log-books, and in two meteorological logs of His Majesty's schooner brig "Macassar" (Lieutenant Commanding T. E. Buys), and His Majesty's schooner "Atalante" (Lieutenant Commanding T. T. Phaff), possessed the means of examining and comparing the observations made by the fishermen.

From the annexed observations which Mr Andrau extracted from these log-books, it is evident how much his work may serve even immediately for useful advice, and how much the Institution, already in favour of the "Great Fishery," may rejoice that Lieutenent Kroef's plan of enriching the experience of one with that of many others, by a systematic regulation of the observations of the fishermen, has been carried out.

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* We are indebted to the Board of Trade for printing these translations; but as they will not be in general circulation, and contain various and valuable information, we have thought that they would be acceptable to the readers of this Journal, and hope that the Scotch Fishery Board will also institute observations in co-operation with our Dutch neighbours, and that our Meteorological Society will assist by its advice. (Ed. W. J.)

The Institution, therefore, has thought it useful to inclose the annexed information in the log-books handed to the mates for filling up, trusting that the fishermen may be thereby encouraged to continue collecting their observations this year, and by so doing to make their own experience the means of obtaining more and more of the object in view.—In the name of the Royal Meteorologic Institution of the Netherlands,

I. VAN GOGH,
Utrecht, April 1857. First-class Naval-Lieutenant.

INFORMATION TAKEN FROM THE LOG-BOOKS OF FORTY-FIVE HERRING VESSELS.

Forty-five vessels had, during the whole fishing time, fished 3266 times, and caught 21,623 barrels of herrings, consequently on an average 6·66 barrels every time the nets were laid; however, there having been 882 times a miscatch, the above-named number really has been caught in 3266 − 882 = 2,384 times fishing. Hence the catch of every time of fishing amounts to 9·1 barrels.

Every vessel has, at an average, fished seventy-two times, and caught 480 barrels.

Everything concerning the catch has been minutely examined, and gives the following results:—

Influence of the Wind.

The course of the wind does not seem to have had any particular influence upon the catch.

It appears, however, that in calms, and with northerly winds, the smallest catches were made.

	Barrels.
With S.S.E. wind the catch has been at an average	8·1
„ S. „ „ „	7·2
„ N.N.W. „ „ „	5·8
„ N. „ „ „	5·2

Influence of the Warmth of the Sea Water.

From the registration of the temperature of the sea water on the surface, it appears that the herring is mostly caught when the surface of the water has an average degree of warmth of 12° to 14° Celsius, or centigrade, corresponding to 54° to 57° Fahrenheit.

Between these temperatures the proportion between catch and miscatch appears to be as 4 to 1; that is to say, if they fished five times, they had one miscatch, whilst the number of barrels for every time of fishing amounted to 8·5 barrels.

The following table gives the proportion between catch and miscatch, as well as the average number of barrels caught in every degree of warmth of the sea, by the confirmation of which the advantage of the catch between the temperatures 12° to 14° (54° to 57° Fahrenheit) will clearly appear :—

Temperature of the Surface.	Proportion of Catch and Miscatch.	Number of Barrels caught every time of fishing.
Fahrenheit.*		
44° to 46°	10 : 10	2·0
46° to 48°	10 : 10	1·9
48° to 50°	20 : 10	2·1
50° to 52°	28 : 10	5·1
52° to 54°	34 : 10	7·0
54° to 55°	42 : 10	8·7
55° to 57°	43 : 10	8·4
57° to 59°	17 : 10	7·7
59° to 61°	15 : 10	7·4
61° to 63°	20 : 10	3·2
63° to 64°	30 : 10	5·7

* Given to the nearest degree.

State of the Sea.

1*st,* It has appeared that the more or less disturbed state of the sea has no influence on the catch, because the proportion between the number of barrels caught in a calm or in a high sea was proportioned as 6·08 to 6·09, or as 1 to 1.

2*d,* However, it is found that the proportion between the number of barrels caught in unsettled and clear water was as 14 to 6, or as 7 to 3. Unsettled water, therefore, is far preferable to clear water.

3d, The green colour of the sea has also the preference over the blue, but as this very likely depends on the greater or less clearness of the sky, too much reliance must not be placed on this phenomenon. Besides, the difference is not very great, the proportion being with green to blue as 7 to 5.

State of the Weather.

With foggy and squally weather the catch has been five barrels,—thus below the average (: 6·66 barrels). With squally and clear weather the catch has been most profitable, having then been 7·3 barrels. With rain the catch has been middling, say six barrels. The influence of the state of the weather is therefore not of very great importance.

All the above-mentioned results have been gained without taking into consideration place and time, and serve chiefly to trace the habits of the herring. It is of more consequence to the fishermen to know the place where most herrings are to be found. By examination of these circumstances they were led to a supposition, which, if confirmed, will have considerable influence upon the profit or loss of a catch. However, as it is of the utmost importance to know whether all the phenomena that appeared during the space of the year 1856 will give the same results in future, it is for the fishermen to gather a new stock of observations, which, having been discussed by the Institution, will, in time, lead us to results, one of which will be, whether the herring is really a migratory fish, which, by the observations of 1856, can only be given as a supposition.

Result as to how far the Observations of the year 1856 *are in favour of the Herring being a Migratory Fish.*

We will shortly mention what gave occasion for a supposition that may be considered of the utmost importance for the catch, and afterwards go on to show the places where in every month the most herrings were caught, in order that the future proceedings of our fishermen may be guided thereby; and by so doing we flatter ourselves that we shall at least overcome in time the greatest difficulty, that of fishing in places where the herring *can not be.*

What gave rise to the supposition that the herring was a migratory fish was particularly the proportion of the number of barrels caught with the times of fishing in every space of one square degree, or rather in a space of 15 miles (Dutch) by 9, taking into consideration the time—that is, the month—in which the fishing took place. Supposing, for instance, that in a certain month it was found that the most herrings were caught between 0° to 1° E. longitude, and 55° to 56° N. latitude, and that the following month the catch in that space was hardly anything, but, on the contrary, that the surface of 1° to 2° E. longitude, and 56° to 57° N. latitude, offered the most favourable proportion between the catch and the number of times fishing, we might come to the conclusion that the herring in the time of one month had migrated in a N.E. direction; and further, supposing that the same phenomenon should be repeated in after years under similar circumstances, and at the same time, then the supposition would become a *fact,* that the herring migrates, and that this migration is regulated by the season.

Now, the monthly returns of the year 1856 show us the following:—

"In June and July the herrings began their migration from the east side of the Shetland Isles by two different routes towards the southward. They were found principally in the latter end of July between 57° and 56° N. latitude, and accumulated in August chiefly between 56° and 55° N. latitude, near the Scotch coast.

"In September, however, the migration began northwards, also by two, but now very broad routes, in consequence of which the herrings were caught with advantage over a large surface.

"In October the herrings had already migrated so far northwards that they were caught most advantageously from 58° to 60° N. latitude, and in November they did not seem to extend farther southwards than the 59th degree."

This is the result of the observations for the year 1856. The following years will show whether this migration of the herrings in that year is only occasioned by accidental circumstances, or will confirm the supposition that this route is taken by them every year; or they will show us that the herrings migrate by other channels also, and therefore are not bound to the route which they took in the year 1856. However this may be, the expected observations will not only throw more light on this subject, but must bring forward very advantageous results for the "Great Fishery." It may therefore be a greater stimulus to continue the observations, and to convince the persons charged with them of the importance of exact returns.

Usually, the fishermen begin to cast their nets in the latter half of June between the Orkney and Shetland Isles. The catch is then very small, which the following table will easily show:—

JUNE.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch in barrels.
		Catch.	Miscatch.	Total.		
61° to 60°	3° to 2° W.	...	2	2	0·	0·
	2° to 1° W.	2	3	5	0·2	1·3
	1° to 0° W.	19	15	34	0·6	20·3
60° to 59°	3° to 2° W.	2	3	5	0·5	2·5
	2° to 1° W.	82	67	149	2·4	357·6
	1° to 0° W.	19	14	33	1·5	49·5
59° to 58°	2° to 1° W.	7	3	10	2·2	22·
58° to 57°	2° to 1° W.	...	2	2	0·	0·
	1° to 0° W.	1	...	1	1·	0·
57° to 56°	2° to 1° W.	...	1	1	0·	0·
	Total, .	132	110	242	1·87	454·2

The average catch of each time of fishing, therefore, amounted to 1·87 barrel. The worst catch was along the whole Scotch coast. On the contrary, the best spaces in that month were easterly and southerly from the Shetland Isles between 60° to 58° N. lat., and 2° to 0° W. long. If, therefore, the herrings arrived in the North Sea between the Orkney and Shetland Isles, then the westerly places must have given the largest number. However, we observe that the places lying more easterly are better, and therefore we come to the conclusion (which is made yet more probable by the observations of the following month) that the herrings arrive in the North Sea by the east side of the Shetland Isles.

JULY.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch in barrels.
		Catch.	Miscatch.	Total.		
61° to 60°	3° to 2° W.	...	1	1	0·	0·
	2° to 1° W.	1	...	1	4·	4·
	1° to 0° W.	53	22	75	5·8	432·
60° to 59°	3° to 2° W.	16	9	25	0·8	20·
	2° to 1° W.	121	110	231	1·9	448·
	1° to 0° W.	46	33	79	4·6	359·4
59° to 58°	3° to 2° W.	39	24	63	0·8	51·4
	2° to 1° W.	39	48	87	1·3	113·
	1° to 0° W.	...	6	6	0·	0·
58° to 57°	2° to 1° W.	61	50	111	2·4	264·4
	1° to 0° W.	100	16	116	5·	584·
	0° to 1° E.	...	1	...	0·0	0·
	1° to 2° E.	1	...	1	2·0	2·
57° to 56°	3° to 2° W.	4	3	7	2·6	18·2
	2° to 1° W.	85	39	124	4·5	558·
	1° to 0° W.	19	12	31	4·7	145·7
	0° to 1° E.	1	2	3	0·3	0·9
	1° to 2° E.	1	...	1	8·	8·
56° to 55°	2° to 1° W.	3	1	4	2·7	11·8
	1° to 0° W.	7	2	9	4·	36·
	0° to 1° E.	...	1	1	0·	0·
	Total,	597	380	977	3·13	3056·8

From this table we observe,—

1*st*, That in the month of July the average catch was 3·13 barrels for each time of fishing.

2d, That the catch was worst along the Scotch coast, and best on the south and east side of the Shetland Isles.

Southerly from the parallel of 59° N. lat. the herrings disappear all at once. They do not seem, therefore, to go up between 1° to 0° W. long., but to divide into different shoals, which generally migrate to the southward by two routes. The one route where the most herrings migrate is very certainly east of 0° long.; but observations on this point are wanted, because no fishing has taken place there. The other route is more in the neighbourhood of the Scotch coast, between 2° and 1° W. long., but this does not seem to be the favourite route. Southerly from the parallel of 58° N. lat., and 1° to 0° W. long., the herring appears again, and becomes more and more numerous between 57° and 56° N. latitude.

The best places in July, therefore, were most probably in the beginning of that month eastwards from the Shetland Isles; later in the month, as the herring migrates more and more to the south, we ought to fish more southerly, particularly between 58° to 57° N. lat., and 1° to 0° W. long., taking care in the latter part of July to be southwards of the 57th degree of latitude, because in August the herrings were already chiefly between 56° and 55° N. lat. As the catch was very inconsiderable in the month of July along the Scotch coast, it would have been better to have remained farther from the shore, and not to have passed 1° W. longitude. It appears from the table for August, on the following page, that the herrings have now become more numerous, because the quantity caught in this and the following month is double, and sometime threefold, that in July. *The place where the herring seems to be chiefly found in August is southwards of the 56th degree of latitude, and particularly near the Scotch coast.* In all the remaining parts of the North Sea the herrings seem to avoid the coast, and the catch there is usually far worse than about twenty miles out.

It is not proved yet, whether the herring migrates farther southwards, because the vessels making the observations have not fished southward of 55° N. latitude.

Certainly this place in particular seems fit for a meeting (rendezvous ?), because during the whole month the herring remains stationary, and not before September do we observe very clearly that the herring returns to the north.

AUGUST.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch in barrels.
		Catch.	Miscatch.	Total.		
59° to 58°	3° to 2° W.	3	2	5	1·8	9·2
	2° to 1° W.	4	2	6	2·7	16·
	1° to 0° W.	1	...	1	0·7	0·7
58° to 57°	2° to 1° W.	16	5	21	3·3	69·3
	1° to 0° W.	76	19	95	5·7	540·5
	0° to 1° E.	11	3	14	7·0	98·0
57° to 56°	2° to 1° W.	1	...	1	2·	2·
	1° to 0° W.	114	85	199	3·7	727·3
	0° to 1° E.	90	59	149	5·3	794·7
	1° to 2° E.	15	8	23	5·2	119·6
	2° to 3° E.	4	2	6	2·	12·
	3° to 4° E.	1	...	1	9·	9·
56° to 55°	2° to 1° W.	12	2	14	22·6	317·4
	1° to 0° W.	41	12	53	17·3	916·6
	0° to 1° E.	30	6	36	13·5	486·
	1° to 2° E.	4	3	7	6·6	46·2
	Total,	423	208	631	6·6	4164·5

In the month of September the quantity caught southwards from 56° N. lat. is evidently very inconsiderable, in comparison with that caught in the month previous.

We now meet the herrings more northerly. The two routes along which they migrate round the north are very perceptible. The one is along the Scotch coast between 2° and 1° W. long., the other between 57° and 58° N. lat., and 0° to 1° E. long. Northwards from the parallel of 58° N. lat. the two routes reunite, and the herrings migrate jointly northwards. According to the distance migrated in the month of September, it would have been best to fish in the beginning of that month between 56° and 57° N. lat. and 1° W. long. to 1° E. long., and then always to pass in a more northerly direction, taking care to be towards the end of the month between 58° and 59° N. lat. and 1° W. long. to 2° W. long.; because in October, as we shall observe presently (see table, p. 60), the most herrings are caught around and in the neighbourhood of the parallel of 59° N. latitude.

SEPTEMBER.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch in barrels.
		Catch.	Miscatch.	Total.		
60° to 59°	1° W. to 1° E.	4	1	5	7·	35·
59° to 58°	2° to 1° W.	3	...	3	5·2	15·6
	1° to 0° W.	49	7	56	9·1	511·5
	0° to 1° E.	36	3	39	16·	628·
	1° to 2° E.	8	1	9	11·6	104·4
58° to 57°	2° to 1° W.	19	1	20	14·1	282·
	1° to 0° W.	113	18	131	7·6	995·6
	0° to 1° E.	155	12	167	15·3	2555·1
	1° to 2° E.	24	4	28	6·	168·
	2° to 3° E.	1	...	1	1·	1·
57° to 56°	2° to 1° W.	20	2	22	9·5	209·
	1° to 0° W.	82	16	98	10·9	1064·2
	0° to 1° E.	42	5	47	10·9	512·3
	1° to 2° E.	7	4	11	6·5	71.5
56° to 55°	2° to 1° W.	...	1	1	0·	0·
	1° to 0° W.	1	3	4	3·7	14·8
	0° to 1° E.	2	2	4	0·4	1·6
	1° to 2° E.	4	4	8	1·2	9·6
55° to 54°	2° to 3° E.	...	4	4	0·	0·
	Total,	570	88	658	10·91	7174·2

The proof that the greater part of the herrings are to be found northwards of 58° N. lat. is given by this Table, showing the quantity caught in that locality. It seems then, that the herrings, in the beginning of this month, pass the 58° N. lat., and proceed to the north more slowly than in the previous month, because we find during the whole month the most advantageous catch between 58° and 60° N. latitude. The best places, therefore, in the beginning of October have been between 58° and 59° N. lat. and 0° to 2° long.; and somewhat later, between 59° and 60° N. lat. of 1° W. long. to 2° E. long., because in November (see table, p. 60) we observe that southwards from 59° lat. hardly anything has been caught.

OCTOBER.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch, in barrels.
		Catch.	Miscatch.	Total.		
60° to 59°	2° to 1° W.	5	1	6	4·	24·
	1° to 0° W.	34	5	39	14·6	570·
	0° to 1° E.	55	8	63	12·6	793·8
	1° to 2° E.	10	1	11	10·	110·
59° to 58°	2° to 1° W.	2	...	2	5·	10·
	1° to 0° W.	120	15	135	8·9	1206·5
	0° to 1° E.	188	18	206	11·4	2352·4
	1° to 2° E.	78	7	85	9·3	794·5
	2° to 3° E.	7	...	7	7·4	52·8
	3° to 4° E.	2	...	2	2·5	5·
58° to 57°	2° to 1° W.	1	...	1	2·	2·
	1° to 0° W.	15	3	18	4·1	73·8
	0° to 1° E.	49	8	57	5·7	327·
	1° to 2° E.	45	5	50	5·5	277·
	2° to 3° E.	3	...	3	5·8	17·4
57° to 56°	1° to 0° W.	7	...	7	5·4	38·
	0° to 1° E.	10	3	13	4·8	62·8
	1° to 2° E.	2	6	8	1·2	10·
56° to 55°	0° to 1° E.	2	...	2	3·	6·
	1° to 2° E.	1	1	2	0·5	1·
55° to 54°	1° to 2° E.	1	1	2	0·1	0·2
	2° to 3° E.	...	1	1	0·	0·
	Total, .	637	83	720	9·36	6734·2

NOVEMBER.

North Latitude.	Longitude.	Number of times fished.			Catch of each time of fishing, in measured barrels.	General Catch in barrels.
		Catch.	Miscatch.	Total.		
59° to 58°	1° to 0° W.	...	1	1	0·	0·
	0° to 1° E.	1	...	1	0·2	0·2
58° to 57°	0° to 1° E.	4	2	6	0·7	4·2
	1° to 2° E.	4	3	7	2·	14·
57° to 56°	1° to 0° W.	5	1	6	1·	6·
	0° to 1° E	6	2	8	1·1	8·8
	1° to 2° E.	1	2	3	0·7	2·1
	2° to 3° E.	1	1	2	0·5	1·
56° to 55°	1° to 2° E.	3	1	4	0·7	2·8
	Total, .	25	13	38	1·03	39·1

We hereby learn, not only that the herring has disappeared between 59° and 58° N. lat., but that the fishing over the whole North Sea southwards from this latitude no longer offers any good results. Had we, therefore, in the month of November still remained fishing, it would have been best to go northwards from the 60th degree of latitude, because, in all probability, we should have still been in the route of the herrings migrating northwards.

The following Table gives the results of the monthly catch, and the proportion between catch and miscatch in every month :—

Month.	Number of times fished.	Number of barrels caught.	Average Catch of every time of fishing.	Proportion between.						
				Catch.		Mis-catch.		Catch.		Mis-catch.
June .	242	454·2	1·87	132	:	110	=	11	:	10
July . .	977	3056·8	3·13	597	:	380	=	15	:	10
August .	631	4164·5	6·6	423	:	208	=	20	:	10
September	658	7174·2	10·91	570	:	88	=	70	:	10
October .	720	6734·2	9·34	637	:	83	=	80	:	10
November	38	39·1	1·03	25	:	13	=	20	:	10
Total .	3,266	21,623	6·66	2,384	:	882	=	5	:	2

We observe thereby that the proportion between the catch and miscatch has been most favourable in September and October, and most unfavourable in June, July, August, and November; whilst the average proportion during the whole fishing time shows 5 to 2—that is to say, that out of seven times fishing, the catch has twice been *nil.* It remains now to be shown, whether the fishermen will obtain better results in future.

The fact of the catch in June, July, August, and November standing in such an unfavourable proportion to the miscatch, seems to lead us to the conjecture that almost all the fishermen in these months fished in places which the route of the herring did not pass; whilst in September and October they happened to find the right places. The question is now, Where do all the herrings that are to be found in the neighbourhood of the Scotch coast in August, and that move in the following months in far greater masses to the north than we find arrive in the beginning of the fishing season, come from all at once? Is their number really less in the beginning of the fishing season? Or is the young herring, up to the months of August and September, so small as to be considerably less than the old one, and therefore able to slip through the meshes of the nets? Or have the fishermen not yet found the right places where the herrings enter the North Sea?

The answer to these inquiries we still leave to the future, trusting that the fishermen, fully convinced of the great importance of correctly answering the questions concerning the more or less advantageous catch, will not only use every exertion to attain this object by fixing the places where the fishing was formerly carried on, but will also continue to make their observations with the same zeal and attention as last year; for it is only by collecting and comparing their observations that a satisfactory result can be obtained.

To the Gentlemen Owners of the "Great Fishery."

By his Excellency the Minister of Home Affairs, a design of Lieutenant N. M. T. Kroef has been handed to the Directors of the Royal Meteorologic Institution of the Netherlands, for the preservation and extension of our "Great Fishery," by means of the composition of a "Herring chart," for the advantage of the proprietors.

The Institution, taking into consideration the great interest that the owners must have in this design, and convinced of its importance, has considered it a duty to take this affair to heart, trusting that the influential persons, and the commercial corporations concerned, will do their utmost to assist these endeavours for the general interest. In accordance with this aim, we give the following details, wants and promises, wherewith the propositions for such charts should be accompanied. Hitherto the reasons for searching in certain places were only based on old habits, and every fisherman worked according to his own ideas, which must necessarily have been very different in proportion as he, with more or less advantage, had had several years in one and the same place an accidental good or bad catch. It is therefore fortunate that Lieutenant N. M. T. Kroef suggested the idea of enriching the experience of one follower of this important business with that of many others, by a systematic discussion and arrangement of the observations made by the fishermen, in order to enable them, under all circumstances, to carry on their occupation to the advantage of our trade and our shipowners, consequently to the welfare of our nation. However, should the Institution even answer its purpose in this particular, should it gather knowledge from observations, and facts from experience, derived from our own as well as from foreign fishermen,—a circumstance extremely necessary for this (formerly so important) branch of industry in its present state of stagnation or even retrogression,—then is this only possible by energetic co-operation of the owners and commanders of herring vessels, which we therefore solicit with becoming urgency.

By the mediation of his Excellency the Minister of the Marine Department, the Institution has been enabled to take the design of Lieutenant N. M. T. Kroef into consideration, and his experience concerning the willingness of the fishermen to make the required observations made the realization of his plan possible; and consequently a log-book has been designed, for which the said plan formed the basis, and by means of which the so much wished-for systematic co-operation of our Dutch fishermen could be ensured. Everything likely to be useful to the practical interest of the fishermen is therein contained. It is the result of experience which one wishes to find in their log-books. Their observations, compared by competent judges, will provide data for the instructions, of which the "Great Fishery" is now in want. This is the reason of the request "only to record proper observations," because it is better to deliver no observations at all than bad ones, which lead to erroneous conclusions.

The log-books, which are given *gratis* to the herring vessels, are, after the voyage is finished, to be sent by the owners or their book-keepers to the Royal Meteorologic Institution of the Netherlands, where they will be delivered for discussion to the Marine Department, which will tabulate the experience of so many fishermen, in order to turn to the interest of the fishery the systematic examination of the inquiries of which the migration of the herring is the object.

That we are greatly in want of such a systematic examination is already shown by the circumstance, that the main point is not even settled yet, whether the herring migrates over a great distance, and if so, by what route;—farther, particularly whether it plunges sometimes deeper, or whether it comes more to the surface; and if so, how this ascending and descending is influenced by a higher temperature of air or water, by wind, by weather, or by electricity of the atmosphere.

It will always remain a mystery as long as the accompanying circumstances are not noted down and systematically combined; but it is equally certain that a good examination always leads to results, and that nature never refuses an answer when questioned well. Why then linger without a correct knowledge? Let our Netherlands fishermen begin to carry out such an examination. By the connections our Government has established with other countries, particularly with England, the Institution will obtain the results gained by the observations of foreign sea-faring men, who will be requested to cooperate in the same undertaking.

The instruments required for making the observations are, one deep-sea instrument and three thermometers, which will be given to the vessels by the owners; whilst the necessary steps will be taken beforehand to instruct the fishermen in their use. The places where the instruments are to be compared will be announced hereafter, as soon as we are certain of general co-operation.

The Institution would, however, much deplore seeing the treasures of experience contained in former log-books and memoranda lost. These log-books would very likely throw more light on the matter, and enable us to make a provisional examination, in order, after the newly-designed log-books shall have been returned, to prepare a solid basis on which to proceed. This would very soon lead to results, which would then be given gratis to all co-operators. By the encouragement of the industrial spirit of foreign nations, a more extensive field for speculation will be opened to them, and our fishermen will therefore soon meet them as their co-operators.

It is therefore not sufficient to hold to old ideas and prejudices; the present age demands the surest and most advantageous manner of proceeding to prevent this branch of industry from being ruined, as others have been, by the continually increasing opposition. Our enlightened Government, always ready to encourage speculations tending to the country's welfare, has promised its protection to the subject in question, and will do everything to assist the designed plan. It has authorized the Institution to open the necessary connections with the inland committees and persons, and will also take the steps abroad which may be thought necessary for the attainment of this great object.

In the log-books, the instruments recommended for making the observations are described. The keeping of the log-books is so simple, that it does not require any instruction; however, it contains one page with designs, more to show the manner of filling up, than to teach the meaning of the superscriptions of the columns. It is sent to you, gentlemen, for inspection, with a friendly request to communicate to the Meteorologic Institution whether the commanders of your vessels wish to co-operate in the above-mentioned subject, and whether you will procure the instruments necessary for that purpose. As soon as a return of the number of co-operating vessels has been received, we shall, with all possible speed, take the steps necessary for the further promotion of the general interest.

Besides the committee of the "Great Fishery" at Vlaardingen, there will doubtless be other committees willing to cooperate in this important purpose.

We again recommend all, for their own manifest advantage, to come to a decision on this point as speedily as possible; and we inclose you the design of Lieutenant N. M. T. Kroef, which has served as a basis for the representation of the object in question.—In the name of the Royal Meteorologic Institution of the Netherlands,

Dr Buys Ballot,
The Chief Director.

Utrecht, March 1856.

H. M. Schooner Atalante,
13th September 1855.

Up to the present day it has not been ascertained whether the herring is a migratory fish, returning yearly, or whether it remains stationary, and only disappears to the bottom.

According to "Gilpin," the herring describes a circle in the ocean, falling north-eastwards on to the west coast of Scotland, and swimming round the Hebrides, Orkney, and Shetland Isles, appears then on the east coast of Scotland, and going up southwards, disappears again through the channel in the ocean. Whilst, on the contrary, two other scientific men, "Fabricius" and "Olufsen,"* believe that the herring is not a migratory fish, but is always at the same place, or prefers to be there. To the latter opinion must be added that of the inhabitants of the Orkney and Shetland Isles, who consider the herring always present, but so far gone down that it cannot be caught during the cold season. This sheltering of the herring, however strange it may seem, is nevertheless *possible*, because it is remarkable that at Aberdeen, where the strand and the bottom of the sea are sandy, the fishers are obliged to go miles out to sea, across Buchanness, to find the herring on the stony bottom: and it seems, therefore, to want stony or rocky ground, with weeds to shelter itself in the rough season. Yet a stony bottom seems not to be absolutely required for shelter, inasmuch as in the sea ("Awe") (?) on the west coast of Scotland, a certain sort of fish is caught only during one fortnight in the whole year, where the bottom is sand.

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* Only last year, whilst Mr Kroef wrote this, the subject was spoken of in the French Academy. Old reasons were presented, but did not lead to a result, there not being sufficient good observations.

There is still another reason in support of the opinion of the two last-named men of science. I found several times, during the three consecutive years that I had the charge of the herring fleet, that the herring, having appeared for several days in abundance, disappeared all at once, the catch became very poor, and the herring never reappeared till after a considerable lapse of time.

In 1854 there were along the Orkneys, in the latter end of May, and up to the middle of June, a large number of herrings that disappeared all at once, and did not return before August, whilst the non-migration of the herring is proved by a catch the whole year round, of a first-rate quality, in the bay "Loch Fyne," which obtains a high price at the market of Edinburgh; and it is here particularly observed that the stay of the herring seems independent of the temperature; for the colder it becomes, the higher in the gulf we find the herring,—even as far as Inverary.

After thus summing up the opinions in favour of the non-migration of the herring, I will now give the reasons *for* the migration.

It is a known fact, that always at certain times of the year the shoal of herrings rises up from the ocean, and appearing to-day on the south point of Shetland, shows itself to-morrow, under similar circumstances of weather, so much more northerly, just as if it was a shoal that made so many miles in the twenty-four hours. If we find a returning Greenlander report that he has met with a shoal of herrings between Faroe and Shetland, we may be sure that the northerly ports of the latter isles will soon be visited by herrings; and somebody at Lerwick told me that, according to his fourteen years' experience, the herring swam fifteen English miles a day. However, if such were the case, from whence, then, the disappearances? And how can one explain the fact, that after a fortnight's catch last year on the east coast of Scotland we read "that at Wick there had been a very good catch," whilst on the neighbouring station, the miscatch or failure still continued?

I am of opinion that to the present time nothing is known certainly about the migration or the stay, or, let me rather say, about the natural habits of the herring; and it is about these points that a collection of observations (which will be developed more fully afterwards) seems so desirable, particularly in combination with observations of temperature, which were formerly recommended for the herring fishery by the Netherlands representative in the Meteorological Congress at Brussels, in 1853.

It will at all events lead:—

Firstly, To a knowledge of the arrival, migration, and stay of the herring, so that we should be able to point out on a chart where it is to be found;

Secondly, To the state of the sea and atmosphere in which the most herrings are to be found;

And, *lastly,* To all the inferences that may be drawn from the knowledge of the habits of the herring, which will surely be based on natural causes.

If we only succeed in forming a herring chart, then the fisherman will know *when* and *where* he has to go to get herring, and he will no longer be dependent on those grounds recommended by experience, but which deceive so often, and which remind one of a remark made by an old fisherman, "that it was Providence that favoured the Scotch in placing the herring on their coast."

Respectfully submitting these remarks to a more enlightened and better judgment, I have the honour to propose that the following notifications and observations should be taken by our fishermen:—

1. Return of the date of casting the nets.
2. Place where, mentioned in latitude and distance from shore (as it is known by experience that the fisherman has very little idea of longitude).
3. Sort of ground, and depth.
4. Direction and force of the wind, and state of the atmosphere.
5. Colour of the water.
6. Temperature of the air.
7. Temperature of the surface.
8. Temperature of the bottom of the sea, and depth.

9. Number of barrels caught, and average size of the herring; and,

10. Particulars, such as high sea, heavy thunder-clouds, &c.; whilst I might add, for the English, where and when the first herrings appeared, and the facts connected with their disappearance.

By a yearly combination of these observations it will be possible, even the first year, to point out in the chart the route which the herring has followed, and suggest beforehand where the same comes from, or where it disappears, and why there are places, as in Loch Fyne, where it always remains: we shall then, perhaps, be able to explain the "*seasons*" which the inhabitants of the west of the Orkneys divide so clearly into the "early" and "late" season; what attracts the herring to its stony coasts; and, lastly, after a long-continued combination of the yearly migrations, we shall be able to expose nature in these abodes of shelter in the ocean, and possess means to form a herring chart in imitation of Maury's whale charts, a short extract of which given to the fisherman in a practical manner will be very useful to him and the "Great Fishery."

Having the honour to be acquainted with the Committee of the Great Fishery, I shall be very much pleased (taking for granted the approval of Government) to interest this corporation in the undertaking, and conclude with the heartfelt desire, that this attempt to be of some assistance to the "Great Fishery" may result in the Netherlands being the first to raise its voice for the examination of all fisheries, and thus contribute to the endeavours of science to become more acquainted with the sea and its inhabitants, as well as with the laws that regulate the universe.

M. N. T. Kroef,
Second-class Naval-Lieutenant Commanding.

On the Gulf-stream. By R. Russell, Kilwhiss.

The existence of this vast current of the ocean has long been known to navigators, and its phenomena have furnished a great amount of speculation among men of science. Its first course is so generally known, that it is unnecessary to give any lengthened description of it. The Gulf-stream, as it runs northwards through the narrow pass of Florida, has a breadth of about 32 miles, and a velocity of 4 miles an hour. According to Professor Bache, it has there a depth of 370 fathoms. Flowing northwards along the eastern coast of the United States, it becomes broader and shallower, and runs less rapidly. At Cape Hatteras, its breadth is 75 miles, and its motion about three miles an hour. In its further course along the coast of the United States it gradually widens, and at length, on the banks of Newfoundland, which Volney not inaptly termed its "bar," becomes comparatively shallow. Indeed, the great depth of the stream in the Straits of Florida, and the shallow current that flows over the banks, has a marked resemblance to that which the Mississippi, and many other rivers present, being of great depth at a certain distance from their mouths, but having little water on their bars—so much so, indeed, that the water in their beds may be said to flow up hill.

From the Banks of Newfoundland the stream is much less marked towards the northward and eastward; for it there appears to spread out, and to form the surface of the ocean itself, causing various and somewhat contradictory opinions to be held as to its extent and influences. Thus Rennell's researches led him to the conclusion, that in ordinary years the warm waters of the Gulf-stream did not extend east of the Azores; but both he and Dr Franklin were of opinion that the great current could be traced quite home to the coast of Europe in 1776. On the other hand, it is common for many writers to ascribe the mildness of the winters of Britain to its shores being washed by the warm waters of the stream; and, with Lord Dufferin, many suppose that the absence of ice in winter in the sea which stretches from Iceland to Spitzbergen, is entirely owing to this Florida stream sending a branch of its thermal waters through the eastern Atlantic northwards into the Arctic Ocean.

The Gulf-stream is, in truth, easily traced along the coast of the United States. Being confined within a comparatively narrow channel, its velocity is considerable, and the warmth of its waters is in striking contrast with the temperature of the Atlantic in the same latitudes. If we regard the ocean betwixt Iceland and the British Islands as a vast branch or continuation of the Gulf-stream, as in some respects it really is, we have no adjoining seas to furnish us with comparisons as to whether the ocean in those parts is abnormally warm or not. At the same time we believe it is in vain to look for a steady current in the North Atlantic, for there we have only irregular or temporary surface-currents, resulting from the variable winds that prevail.

But while it seems to us that very inaccurate ideas exist regarding the Gulf-stream in the latter part of its course, or what is considered to be its course, still more inaccurate ideas prevail regarding its influence on the climate of Western Europe. Thus the winter climate from Iceland to Spitzbergen is far milder than that of the corresponding latitudes of North America, and the intense colds of the latter are often ascribed to the ice-bearing currents which run southwards along the Labrador coast, while the comparatively high temperature of the European coast in winter is ascribed to its being washed by the warm waters of the Gulf-stream. The polar current and the Gulf-stream undoubtedly exercise a certain amount of influence on the continents to which they are contiguous, but their influence is much less potent than that of the winds that give rise to and maintain these currents of the ocean.

In endeavouring to assign a due value to each of the agents that render the winter climates of the opposite shores of the Atlantic so different in character, the subject will be best treated by considering it under the following heads:—

1*st*, The prevailing direction of the winds in the tropics, and also in the Western and the Eastern Atlantic.

2*d*, The effect of the wind of the tropical and extratropical latitudes on the currents of the Atlantic, and the reciprocal influence of the winds and currents on the climates of North America and Europe.

When strong west winds prevail on Lake Erie, its waters are accumulated on its eastern shore to such an extent that the Niagara River at the great falls rises about 4 feet. This is well known to be caused by the friction of the wind on the surface of the lake. Strong south-east winds cause the waters of the Mediterranean to accumulate in the Gulf of Lyons. West winds cause low tides on the coast of the United States, and high tides on that of Europe. It is generally admitted that the gentle trade-winds assist in maintaining the current which flows from the Caribbean Sea into the Gulf of Mexico. These, and other instances that could be mentioned, are sufficient to show that winds must cause currents in the ocean. In discussing the phenomena of the Gulf-stream, therefore, it is of primary importance to consider the prevailing directions of the winds throughout the year, not only in the tropics, but in the Eastern and Western Atlantic.

Within the tropics, between the continents of Africa and America, easterly winds prevail with great constancy. It is found that the currents of the ocean and the winds in these regions have a common direction. In the Caribbean Sea, also, the winds are almost constantly southerly in summer, and favourable to currents setting in towards the Gulf of Mexico. Southerly winds are also the prevailing ones over the continent north of the Gulf, as well as along the coast of the United States in summer, and thus assist in propelling the Gulf-stream in its north-easterly course towards Iceland and the Arctic Ocean.

In winter, however, there is a considerable change in the atmospheric currents of North America. During this season the south wind blows much seldomer over the continent and its adjoining seas. The south wind blows as regularly in summer over the Gulf of Mexico and the territory of the United States west of the Mississippi as the trade-winds in the middle of the Atlantic; but in winter the south winds never blow long with force, being soon displaced by the cold westerly winds from the Rocky Mountains. These westerly winds, which I have elsewhere formerly described,* are the terminating winds of the American storms. They descend into the Gulf of Mexico as "Northers" during the cold season, and blow with great violence. In the warm season, on the other hand, northerly winds are scarcely known in these parts. An extract from the meteorological register kept at Fort Brown, on the Rio Grande, in Texas, latitude 25° 53′ during the months January and July 1856, will show the influence of the season on the prevailing winds there. The observations are taken three times a-day, and the numbers show how often the winds blew from the different points of the compass.

January 1855.

N. 14=N.E. 7=E. 21=S.E. 11=S. 12=S.W. 0=W. 2 =N.W. 26.

July 1856.

N. 0=N.E 0=E. 13= S.E. 72=S. 7=S.W. 1=W. 0 =N.W. 0.

These observations show us that the "Northers," represented by the N., N.E., W., and N.W. winds have no place in the system of aerial currents of summer. The southerly winds, during the hot season, are not displaced by the cold westerly winds which are converted into northerly winds during the cold season in the Gulf of Mexico and Caribbean Sea. One fact, therefore, ought to be borne in mind, that the winds in those regions during winter are rather adverse to the accumulation of water in the Gulf of Mexico. For this reason we must look to other agents in accounting for the remarkable permanency in the Gulf-stream throughout the year, seeing that the winds are unfavourable to its propulsion in the first part of its course.

Southerly winds blow longer in winter on the Atlantic coast than they do west of the Mississippi; but still they rarely blow with force longer than forty-eight hours at a time before they are displaced by the westerly cold winds from the interior. Though these westerly winds are by no means so favourable to the propulsion of the Gulf-stream as the southerly, they may so far assist. On returning from the southern States to New York in April 1855, we found that two days of a strong gale from the west, caused low tides at that port. The temporary depression of the ocean then prevailing off the coast would actually furnish a lower level in the ocean into which the waters of the Gulf-stream would flow, at the same time that its surface would be blown off towards the eastward along with the sea forming both its banks. The enormous depth of the channel of the Gulf-stream along the American coast, and the vast momentum of such a body of water, renders it much less subject to be influenced by temporary currents of wind blowing contrary to its course. Sometimes, indeed, as Humboldt tells us, the winter north winds in the Straits of Florida cause surface currents to flow towards the south, while the great body of the water is out of the reach of such temporary checks.

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* North America, its Agriculture and Climate, p. 313.

The influence of the winds on the currents of the ocean are well shown by the extension of the polar current and Gulf-stream at different periods of the year. The north-west winds, that blow with great fury on the Labrador coast in winter and spring, are highly favourable to the polar current, which flows beneath the Gulf-stream off the coast of Newfoundland. Owing to these winds, this cold ice-bearing current then encroaches greatly on the Gulf-stream: We are told by Lieutenant Maury, that "in winter the volume of cold water on the American, or left side of the stream, is greatly increased. It must have room, and gains it by pressing the narrower waters of the stream farther to the south or right. In September, the temperature of these cold waters is modified; there is not such an extent of them, and then the warmer waters in turn press them back, and so the pendulum-like motion is preserved." In other words, the researches and charts of Maury show that the Gulf-stream flows much farther to the north west in the latter part of summer than in March. This circumstance can only be attributed, we think, to the greater prevalence of southerly winds in summer forcing the warm water of the Gulf-stream over those of the cold polar current.

We quite concur, however, with Lieutenant Maury, that although the trade winds, by acting on the waters of the tropical seas, and forcing them into the Caribbean Sea and Gulf of Mexico, may *assist* to give the Gulf-stream its initial velocity, they are inadequate of themselves to such an effect. Major Rennell and others have assumed that the level of the Gulf of Mexico is much higher than the Atlantic or the Pacific in the Mexican coast, and that the Gulf-stream is "an immense river descending from a higher level into a plain." Maury's reasoning on this point appears to us decisive. "If it be necessary to resort to a higher level in the Gulf to account for the velocity off Hatteras, I cannot perceive why we should not, with like reasoning, resort to a higher level off Hatteras also to account for the velocity off the Grand Banks, and thus make the Gulf-stream, throughout its circuit, a *descending* current; and, by the *reductio ad absurdum,* show that the trade-winds are not adequate to the effect ascribed. Moreover, the top of the Gulf-stream runs on a level with the ocean, therefore we know it is not a descending current."

As we leave the American coast, however, and travel towards the European, we find that south-west winds are not only common in summer, but in winter. During mild seasons, as in December and January last, south-west winds sometimes blow for weeks at a time. This state of things never occurs along the coast of America washed by the Gulf-stream, else they would occasionally have winters far warmer than our own. Professor Coffin, in his valuable memoir, in the Smithsonian Contributions to Knowledge, "On the Winds of the Northern Hemisphere," has furnished a most interesting chart, in which he shows a great predominance of westerly winds, not only on the European continent, but in the ocean extending into the Arctic circle betwixt Spitzbergen and Iceland. Now, it is a remarkable fact, that this very region of the ocean in which Coffin has shown that the resultant direction of the winds is from a point betwixt the south and west, is precisely that in which Maury and others consider that the Gulf-stream sends one of its principal branches. On the other hand, the region in which north-westerly winds prevail is also that in which the polar current flows in the same direction as the wind. Both in the Eastern and Western Atlantic, then, there is a very general coincidence betwixt the directions of the winds and the currents of the ocean.

While we agree with Lieutenant Maury, that the trade-winds alone are inadequate to the production of the Gulf-stream, we are entirely opposed to his notion, that the winds have little to do with the general system of aqueous circulation of the ocean. We think he should have exhausted the influence of the other winds on the ocean in the regions over which the Gulf-stream flows, before giving so much attention to what he calls "galvanic influences." Have the winds in the extratropical latitudes not as great a share in its production as the trade-winds?

We believe that the winds are the prime agents in producing the phenomena of the Gulf-stream; but in the discussion of these phenomena a beginning has generally been made at the wrong end, which has given a false view to the whole subject. We must bear in mind, that if the gentle trade-winds were sufficient, as some affirm, not only to cause currents in the ocean within the tropics, but to heap up water in the Gulf of Mexico, the boisterous south-west winds that often prevail in the Eastern Atlantic must heap up the waters on the European coast, as well as drive them into the Arctic Ocean. As already stated, the surface-currents off the European coast, which are regarded as a continuation of the Gulf-stream, are merely the production of the south-west winds. These winds must lower the level of that region of the Atlantic from which they blow; and no doubt the pouring in of the waters of the Gulf-stream to restore the temporary depression, is a much more powerful agent in giving force and permanency to the Florida stream than the action of the trade-winds. Having held these opinions for some years, we were recently much gratified to find the following passage in the writings of the late Hugh Miller:—

"Uncle Sandy has shown me that an immense granitic boulder in the neighbourhood of the town, known for ages as the Clach Malloch, or Cursed Stone, stands so exactly in the line of low water, that the larger stream-tides of March and September lay dry its inner side, but never its outer one;

round the outer side there are always from two to four inches of water; and such had been the case for at least a hundred years before, in his father's and grandfather's day; evidence enough of itself, I have heard him say, that the relative levels of sea and land were not altering; though during the lapsed century the waves had so largely encroached on the low flat stones, that elderly men of his acquaintance, long since passed away, had actually held the plough when young where they had held the rudder when old. He used to point out to me *the effect of certain winds upon tides.* A strong hasty gale from the east, if coincident with a spring tide, sent up the waves high upon the beach, and cut away whole roods of the soil; *but the gales that usually kept the larger tides from falling during ebb were prolonged gales from the west. A series of these, even when not very high, left not unfrequently from one to two feet water round the Clach Malloch during stream-tides that would otherwise have laid its bottom bare; a proof, he used to say, that the German Ocean, from its want of breadth, could not be heaped up against our coasts to the same extent by the violence of a very powerful east wind, as the Atlantic by the force of a comparatively moderate westerly one.* IT IS NOT IMPROBABLE THAT THE PHILOSOPHY OF THE DRIFT-CURRENT, AND OF THE APPARENTLY REACTIONARY GULF-STREAM, MAY BE EMBODIED IN THIS SIMPLE REMARK."—(*My Schools and Schoolmasters*, chap. iii.)

The fishermen in the Firth of Forth say the tides never rise very high with east winds except there is a west wind blowing at no great distance out in the Atlantic. On the day after the violent gale of the 6th and 7th February 1856, of which I gave an account in the October number, 1856, of this Journal, the tides rose unexpectedly to an unusual height in the Tay and east coast of Scotland.

What a magnificent theme for investigation or speculation do these facts present? The winter storms sweep the Atlantic and western coast of Europe, and heap up the waters for hundreds of miles beyond our shores. They travel from W.N.W. to E.S.E., but the wind almost invariably either begins or blows during the greater part of the storm from a southerly quarter, and thus the surface of the sea is driven from a lower to a higher latitude. The stormy south-west winds that prevail in Iceland and the Faroe Islands are thus the prime agents in producing the currents washing their shores, and which many choose to call a branch of the Gulf-stream.

We have little ground for supposing that there would have been any currents in the North-eastern Atlantic that could have been regarded as a general prolongation of the Gulf-stream if north-easterly had been the prevailing winds on the coasts of Norway and Britain in winter. Instead, then, of the greater initial velocity of the Gulf-stream in the Florida straits being caused by a greater accumulation of water within the Gulf, it must rather be attributed to a greater prevalence of south-westerly winds in the North-eastern Atlantic; and instead of the stream running into a lower level near the European coast, it is forced by the winds up hill, in the same manner as the tropical waters are forced into the Gulf of Mexico by the trade-winds.

On the other hand, the waters of the Atlantic, between Iceland and the Norway coast, are driven by the south-westerly winds into the Arctic Ocean, and keep an open sea in those high latitudes during winter. The comparatively warm currents that flow into the Northern Sea must find an exit either as an under or surface current. As no under-current has been discovered along the European coast, there is considerable probability that, favoured by the north-easterly winds, which are not uncommon within the arctic circle, a current is produced that flows westwards. This, after being cooled down, forms the fountain-head of the ice-bearing current that flows along the Labrador coast and encounters the Gulf-stream off the Newfoundland coast.

In summer, the easterly winds in the seas surrounding the West India Islands, the southerly in the Caribbean Sea and Gulf of Mexico, as well as along the whole course of the Gulf stream, as far as Iceland, assist in propelling this vast oceanic current. But all these concurring influences are not more powerful than are the south-westerly winds in the North-eastern Atlantic, which not only blow in summer, but in winter, when the winds in the Gulf of Mexico and along the coast of the United States are not so well calculated to maintain the flow of the Gulf-stream. We must therefore regard the south-west winds, on the European coast, as Hugh Miller sagaciously hinted, as the principal agents in drawing the waters of the Gulf-stream along the coast of the United States during the winter season. Indeed, with south-westerly winds prevailing in the Northern Atlantic, there would be a current through the Straits of Florida though the tropical regions were constantly calm.

The deep channel of the Gulf-stream off the American coast renders the vast body of water little under the influence of winds blowing contrary to its course. The stream, by this peculiarity, pours in a vastly larger volume of warm water into the North Atlantic in winter than would have been the case had it been shallower, but broader. If there had been no islands, and a deep sea in those parts, the tropical water would have escaped into the North Atlantic over a greatly wider surface, so that in all probability it would have been as difficult to trace a permanent current there as off the coast of Norway.

This supposition is favoured by the following considerations. The researches of Maury have shown that the south-west winds north of the calms of Cancer, where the ocean is covered with sea-weed, blow with great regularity in summer in the middle of the Atlantic. The winds blow both towards the north and south from this calm region, and must undoubtedly form surface-currents in the ocean coinciding with the winds. The southerly currents that are said to prevail on the coast of Spain and Britain in all probability have their sources where these southerly winds spring up; and hence the warmest water that surrounds the British islands in winter is not derived from the Gulf-stream,* but from the placid region of the Saragossa Sea, where the sky is generally cloudless. Through the friction of the winds on the surface of the sea, the ocean currents, and the aerial currents, have a common place of origin. On the other hand, as we have elsewhere shown* on the thirtieth parallel of north latitude, the space between the sixtieth degree of west longitude and the base of the Rocky Mountains forms the gateway through which the southerly winds and storms cross from the tropics to the temperate latitudes. The Gulf-stream, it is curious to observe, also flows through this space as well as the summer southerly winds.

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* Though we cannot agree with Lieutenant Maury in supposing that a southern current of water can flow across the north-east trade-winds and calms of Cancer in the Mid and Eastern Atlantic, we are glad to have the opportunity of quoting the following passage from Maury's Sailing Directions;—"The warm waters that are found east of the usual limits assigned to the Gulf-stream and between the parallels of 30° and 40° north do not come from the Gulf-stream."

It is well known that part of the great polar current, in its course to the tropics, flows under the Gulf-stream off the coast of Newfoundland. Its exact direction is in a great measure involved in obscurity; but there is no great improbability involved in the supposition that it may flow as a submarine current towards the Saragossa Sea, and assist in supplying the void which must arise from the surface-currents produced by the winds that blow almost constantly, from both sides of it, towards the equator and towards the poles.

We have attempted to show that the so-called Gulf-stream results from the winds in the North Atlantic and tropics, causing currents in the ocean by their friction on its surface. *The course of the stream in some measure shows the resultant force and direction of the winds in the Atlantic throughout the year.* Its motion along the coast of the United States resembles the force stored up in a fly-wheel, inasmuch as its narrow channel is a means of conserving that force which would be more readily spent were it spread over a broader channel, and had had a greater surface subjected to the contrary winds which frequently prevail in winter. We must now consider the second point in analyzing the phenomena connected with the Gulf-stream.

The effects of the Winds of the Tropical and extra-Tropical latitudes, on the currents of the Atlantic, and the reciprocal influence of these Winds and Currents on the Climates of North America and Europe.—Our knowledge regarding the laws of heat is not such as admits of us treating this head with the amount of precision which the subject demands. The outlines of the question, however, are so distinctly and broadly marked, that we have often wondered that scientific men have generally ascribed an exaggerated influence to an element which is undoubtedly not the chief in the production of effects. We formerly wrote on this subject.

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* North America, its Agriculture and Climate, page 309.

"If the *mere* proximity of a warm current of water to any country should have much influence on its winter temperature, the eastern States of North America should have very warm winters; but the isothermal line which runs over the British Islands in January descends as low as latitude 37° in America, where the temperature of the Gulf-stream not far from the coast is 20° higher than that of the sea of our own shores. If an easterly wind had constantly prevailed on the east coast of America, then the eastern States would have had very warm winters. But, as Dove has justly remarked, the north-west winds in the United States and Canada are the cause of their cold winters. The influence of the Gulf-stream is thus scarcely felt in raising the mean temperature of these coasts, but the changes in the direction of the wind often cause a difference of more than 60° within twenty-four hours in the winter months."*

South and south-east winds, in winter, are very cold on the Atlantic seaboard for the first day that they blow, although they cross over the warm waters of the Gulf-stream. In illustration of this we may mention a circumstance which struck us particularly during our residence at Washington in December 1854. After two days of strong due west winds, with a bright sky and thermometer at 10° Fahr., which froze up the Potomac in a single night, though it is more than a mile in breadth,—a calm day succeeded. On the next day the wind changed to the south, and blew pretty hard for twenty-four hours. The wind travelled right up the Gulf-stream, but notwithstanding this, its temperature all the time did not rise above the freezing point. Calling the attention of Professor Espy to this cold southerly wind, he assured us that such was invariably the case, as the immense space to the south, over which the cold west winds sweep in the winter storms, render the south winds cold for the first day that they blew.

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* Agricultural Gazette, 21st January 1854.

It ought to be kept steadily in mind that a warm surface has very little power of imparting heat to the atmosphere *until the dew-point is raised;* when, however, air contains a large quantity of vapour, it is only slowly cooled down in travelling over a level surface covered with snow or ice.

It is well known that the variable nature of the climates in extra-tropical latitudes is owing to changes in the direction of the winds; the north winds bring cold, and the south heat. The effects of the changes of wind on the temperature are much greater in winter than in summer, in consequence of the influence of the sun in the latter season. For this reason the mildness of winter climates in the northern extra-tropical latitudes is more owing to the prevalence of southerly winds than to the proximity of warm currents of water. These, no doubt, exert a very considerable amount of influence, but they usually owe their existence to warm winds.

We have already shown that the direction of the winds of the United States and British possessions of America is more under the influence of the seasons than in Britain. Intensely cold westerly winds blow with great violence, and sweep the eastern part of the American continent in winter. These westerly winds descending into the Gulf of Mexico, are known as "Northers," and lower the temperature throughout the gulf, and also part of the Caribbean Sea. It is these winds, coming from the cold continent, that impart the peculiar features to the climate of those regions.

When this cold air, which rests on the gulf, after the north winds have ceased, reflows northwards, over the continent, it is not sufficiently warmed and saturated with vapour, and remains cold during the first day that it blows. The southerly winds, however, would soon cause a high temperature over the territory of the United States in winter, did they blow sufficiently long, but they are quickly displaced by the cold westerly winds. This is the chief reason why Canada has a much colder winter than France.

Florida has the warm waters of the Gulf of Mexico on the one side, and the Gulf-stream on the other, yet both are insufficient to protect the orange trees in the northern half of its peninsula from being killed down now and then by frost.

In fact, the States along the northern shore of the Gulf of Mexico are all subject to intense colds during the winter months, when northerly winds prevail; and the character of the vegetation is totally different from that in corresponding latitudes of Africa and Europe. It cannot for a moment be contended that the Gulf-stream is the cause of the winter climate of the south of Spain being so much milder than that of the Carolinas. At what point, then, of the European coast must we attribute the mild winters to the influence of the Gulf-stream? We must confess ourselves altogether unable to answer the question.

The council of the Royal Society, in issuing a report in 1855, for the guidance of the Board of Trade, in collecting meteorological observations, fall into an error which is by no means an uncommon one, that of attributing unusually mild winters in Britain to unusual extensions of the Gulf-stream. Thus, it is stated, "There can be little doubt that Major Rennell was right in ascribing the unusual extension of the Gulf-stream in particular years to its greater initial velocity, occasioned by a more than ordinary difference in the levels of the Gulf of Mexico and of the Atlantic in the preceding summer. An unusual height of the Gulf of Mexico at the head of the stream at its outset in the Straits of Florida, is a fact which may admit of being recognised by properly directed attention; and as it must precede by many weeks the arrival of the warm water of the stream at above 3000 miles distant from its outset, *and the climatic effects thence resulting, it might be possible to anticipate the occurrence of such unusual seasons upon our coasts.*"

This paragraph follows a notice of the unusually mild weather of December 1821 and January 1822, which was characterized as "most extraordinarily hot, damp, stormy, and oppressive;" that "the gales from the west and south-west were almost without interruption," the "fall of rain was excessive," and "the barometer lower than it had ever been known for thirty-five years before." It appears to us that the prime error of the council of the Royal Society consists in supposing that our mild winters are owing to the Gulf-stream running with greater velocity along the Florida coast, instead of referring them to the continuance of south and south-west winds.

It must be still fresh in the recollection of our readers that December and January last (1857–8) were remarkably mild; and no doubt the temperature of the sea around the coast was high for the season. So long as the south-west winds continued, grass kept green and flowers were plentiful, but the warm water surrounding our island was no protection after the north-east winds were established in March, which was as intensely cold for the season as December was uncommonly warm.

The language used by the council of the Royal Society implies, that the greater initial velocity of the Gulf-stream in the Straits of Florida is the cause of the predominance in Europe of the south-west winds during mild winters. But it is surely nearer the truth to say that the mildness of our winters is owing to a great prevalence of south-west winds; and more than this, if the Gulf-stream can be more readily traced home to the continent of Europe in one season than another, it must be owing to the friction of the south-west winds causing currents in the sea towards our shores. It greatly simplifies our conceptions of the forces concerned in propelling the Gulf-stream to regard, as Hugh Miller has done, the surface-currents which the south-west winds create in the north-eastern Atlantic as playing the chief part in the production of the phenomenon.

In the middle part of the North Atlantic, no doubt, these surface-currents may be regarded as a continuation of the Gulf-stream. Coming directly from the stream, they assist in mitigating the rigours of the winter of Spitzbergen and Iceland. But since they owe their existence to the southerly winds of those latitudes, it is surely illogical to consider the Gulf-stream as the prime agent in modifying the climates of these regions. On this subject we will only transcribe what we wrote some years ago:—

"For some weeks before and after Christmas 1852, the mean temperature was from 5° to 8° above the mean for the season. The early part of the winter was mild and rainy; in short, we had the temperature of April, with great floods. But what an extraordinary contrast have we in 1853–4! The mean temperature of the week ending 15th January was 5° below the average of the season, while the weeks ending 22d, 29th, and 5th February were 7½°, 10¾°, and 9½° respectively below the average.

"What, then, is the cause of this great variation in the temperature of this season and of last year? Can we for a moment suppose that it is owing to any difference in the temperature of the narrow stream which issues from the Gulf of Mexico, and is supposed to spread its waters over the wide bosom of the Atlantic, and to be the prime agent in imparting warmth to the whole ocean that washes the western coast of Europe. We think it is very questionable whether the Gulf-stream is the cause of the high temperature of the sea around the British Islands.

"In the Eastern Atlantic, south-west winds are far more prevalent than any other; when they blow for any length of time, they cause slight surface-currents of water to flow in the same direction. Coming from a lower latitude, they tend to warm, and to keep warm, the space over which they travel. It is the south-west winds which retain the heat in the waters over the supposed course of the Gulf-stream, and cause the high winter temperatures over Western Europe. This much is certain, where the south-west winds are not felt, the influence of the Gulf-stream is not felt. Had east winds been at all common at this period of the year, our winters would be much more severe than they commonly are, and we should have heard much less regarding the influence of the Gulf-stream."*

In a paper read before the British Association at Cheltenham, an extract of which was given in the "Athenæum," it was shown (we quote from memory) that the dew-point of the south-west winds on the south-west coast of England was often higher in winter than the temperature of the sea. This shows that the waters around our coast are not the source of the high temperature of the south-west winds, which actually raise the temperature of the sea. Both these winds and the currents they cause to flow towards our shores have their origin north of the calms of Cancer, in a part of the Atlantic which no one can consider as having its temperature raised by the Gulf-stream.

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* Agricultural Gazette, January 21, 1854, page 42. We are glad to see that others are now taking up similar ground. The author of the able and discriminating outline of Maury's labours, in the May number 1858, of the North British Review, sums up this subject:—"We feel we are not presumptuous in questioning the opinion that the Gulf-stream, though it may influence, does not regulate the climate of the Northern Hemisphere."

On the other hand, as already suggested, the Gulf-stream may visit Iceland and the Arctic Ocean, for it is driven in that direction by the south-west winds. The vast expanse of comparatively warm water that lies betwixt our shores and Greenland serves to temper the rigour of our north-west winds in winter, which would be as intensely cold as they are in Labrador were the intervening sea covered with ice. Thus the influence of currents of water and air are reciprocal; but still we must regard the greater prevalence of south-westerly winds in winter in the Eastern Atlantic as the prime cause of its mild winter climate.

Not only do the warm waters surrounding our shores temper the winds that blow from Greenland in winter, but they also temper the winds from the continent of Europe. The German Ocean, though of no great breadth, so far warms and moistens the east winds before they reach our coast; and our Scottish rivers seldom freeze up in winter, a striking contrast to the effects produced on continental rivers in corresponding latitudes.

It has been remarked that the temperature of the winter months is higher on the coast of Norway than it is on that of Denmark, or even farther south. This has been ascribed to the British Islands acting as a barrier to the Gulf-stream flowing to the Danish coast. In this instance, however, we must again ascribe the phenomena to the influence of the winds. The Norway coast is not warmer in winter than the Danish coast because it is visited by the Gulf-stream, but because south-west winds are more prevalent there. On this point Professor Espy has ingeniously remarked,—"In Norway the air on the eastern side of the mountains in winter is much colder than on the western side, and of course denser; therefore it seems highly probable that the air on the western side has a greater perpendicular altitude than on the eastern, and of course will roll over in the upper regions from the west of the mountains to the east; and as the mountains will hinder the air below from flowing towards the west, which it would do were the mountains not there, the wind will constantly press in below from the west to supply the deficit on the west side caused by the overflow to the east above. This view explains both the rains on the west side of the mountains in winter, and the reason why the air blows below from a warm ocean towards a cold continent during the winter, which would not be (? so often) the case if the mountains were not there." In other words, the mountains in Norway hinder the cold air resting upon the continent from flowing into the Atlantic as under currents or east winds, which are far more common in Denmark, where there are no high mountains to act like a wall in preventing their flowing more frequently into the German Ocean. The British Islands, and the European coast from Denmark to France, would have had a still milder climate if a high chain of mountains had run along the land at a short distance from the sea. The mountains of Norway no doubt assist in propelling the south-west winds of the Atlantic, on the same principle as that on which, as Espy has pointed out, the Himalaya Mountains are concerned in the vast extension of the monsoons of India.

To recapitulate:—The Gulf-stream appears to be the joint effect of the friction of the trade winds and the south-west winds of the Northern Atlantic. The climates on the opposite coasts of Europe and America are regulated by the prevailing winds. The westerly or land winds, which sweep across the territory of the United States north of the Gulf of Mexico, render the winter intensely cold; while the prevalence of south-west winds in the Eastern Atlantic imparts a comparatively high temperature both to the sea and adjoining coast. And, finally, the warm waters which the southerly winds force into the North Atlantic become a most important element in mitigating the rigour of the winter north-westerly winds on the European coast, as well as the easterly in the British Islands.

On the Compound Nature of the Cormophyte. By ALEXANDER DICKSON, Esq.*

The investigation of the nature of the plant is one of the highest importance. It will be only when the phytologist is able to raise himself from his present position of doubt, and show satisfactorily what a vegetable is, that any hope of attaining to great general views in the field of biological science can be entertained. I do not here refer to the abstract definition of the *vegetable* as distinguished from the *animal*, believing that by the advance of science this is becoming daily more difficult, but allude to the more important question as to whether any given and acknowledged vegetable is a simple or compound organism; if compound, of what its members consist, or if there be such a thing as a vegetable individual at all.

The zoologist has done his part, and that well; but is it not rather to the discredit of botanical science, that, when its sister sciences are day by day acquiring increased definiteness, its students should be halting among theories whose name is legion, and hanging their heads when asked the apparently simple question, What is a vegetable?

Vegetable physiology has done much to bridge over the gulf which had so long appeared to separate the animal from the vegetable, and has led to the fond hope that they are capable of strict morphological comparison. Plants have been compared with plants, and their homologies have (at least in the higher forms) been successfully traced; but we have indeed made but little progress until we can attach a meaning to the different structures that we are comparing, and which can be done satisfactorily only by discovering what relation they bear to those of the animal organism.

The non-scientific observer is very much in the habit of looking upon plants as things with which he stands in no relations of fellowship. He may sometimes have the resemblance to himself of many animals forced upon his notice, and go the length of calling himself an animal, but the idea of classing himself along with plants appears preposterous; these he views as something entirely distinct,—almost as much so as rocks or minerals. Even the botanist can scarcely realize that those beautiful structures, which he plucks and mutilates without remorse, consist of living, breathing beings, living as he does upon this earth to enjoy it, and subject to the same mysterious and irresistible law of death which is inherent in his own constitution.

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* Read before the Botanical Society of Edinburgh, 13th May 1858.

The subject which I at present attempt to treat has very important bearings upon phytological classification; the determination of the vegetable individual being the only means by which we can recognise the true values of the different structures composing the vegetable organism.

I cannot pretend to have given in the following remarks a complete solution of this very difficult problem; I shall have attained my object however, if I have afforded any suggestions which may lead others to the farther prosecution of this investigation.

When we examine one of those plants (the Cormophyte) which form the subject of this paper, we find that it can be broken up into a greater or less number of pieces, each of which possesses an inherent vitality, inasmuch as it may form another plant similar to that of which it was originally a member. If we suppose that the vegetable organism is possessed of a psychical or immaterial essence, it follows that there is in the plant, not one, but several psychical elements, one of which, at least, may be supposed to reside in each portion capable of continued independent growth. This I think must be at once apparent, since it cannot be imagined that a psychical element—or, in other words, an individual being or entity—is divisible, or that the mere act of division can call into life beings which had previously no existence. We have examples in many plants of natural dismemberment, as in the detachment of axillary buds in *Dentaria bulbifera*, *Lilium bulbiferum*, &c. These buds cannot be held by the philosophic botanist as essentially different from those which produce persistent branches; and yet, without doubt, new and independent organisms originate in this manner.

On the other hand, if we imagined the plant to be destitute of an immaterial element, as distinguished from a force or forces provisionally termed vital, but supposed to be essentially physical, we might view the various extensions of the plant, not as individuals, but merely as propagations of such arrangements of elementary particles, and of such forces as might be supposed to produce the phenomena of plant life.

There are certain physiologists who would thus separate *organisation* from a *necessary coexistence of an immaterial element*, and who, although admitting the existence of an immaterial element in the higher organisms, yet deny that it has any necessary connection with the development of the material structure. Such physiologists can with perfect consistency imagine that an organism in which they can perceive no manifestations of intellect, and no movements but what are apparently excito-motory or mechanical, that such an organism as they find in the plant is the product of a complex system of mere chemico-physical forces, inanimate as the elements by which it is surrounded, playing its part in the economy of nature, not for its own sake or enjoyment, but merely as a beautiful instrument contributing to the harmony which exists throughout the universe. These physiologists, however, have not been able to show that, in the higher organisms, the processes of cell-development and growth can take place beyond the sphere of the influence of a psychical element; they have never shown that cells, detached from a non-gemmiparous* animal, can continue the phenomena of assimilation and multiplication apart from any connection with the body in which the immaterial essence resides. Without such proof I imagine that this theory cannot be held to be properly sustained.

In relation to this question I venture to submit the following propositions:—

1*st*, That under ordinary circumstances, what are termed elementary particles of matter combine to form inorganic compounds alone.

2*d*, That there must be some medium, through the agency of which the particles of matter forming an organism work in harmony towards a common end, producing thereby the most admirable and complex piece of machinery.

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* There is always a source of fallacy from the possible existence of individualized germs in any portion which may be detached from a *gemmiparou* organism.

3d, That, whatever its nature and ultimate connection with the body may be, the psychical element is manifested more especially through the agency of the nervous system.

4th, That upon the working of the nervous system is dependent the proper nutrition, and consequently the *development*, of the different parts of the organism.

5th, That the immaterial element is capable of acting upon the material structure.

That matter, in ordinary circumstances, has no tendency to form other than inorganic compounds is sufficiently evidenced by the fact that the chemist has not as yet been enabled to form a single organic compound, much less an organised tissue, from its elements. In conceiving of the formation of an organism, we must suppose either that the particles of matter are possessed of a certain intelligence which enables them to work towards a common end, or that there is some other medium or influence (whether without or within the organism) by means of which this effect is produced, since it appears inconceivable that these particles should form such a machine by accident.

That the nervous system is, in the higher organisms, the medium of psychical manifestation is admitted by every physiologist who believes in the existence of an immaterial element; and that upon this system is dependent the proper nutrition of the body, is a doctrine allowed by all.

That the *immaterial* element is capable of acting upon the *material* is sufficiently evidenced by the action of the will upon the nervous substance conveying stimulus to a muscle, of the emotions upon different secretions, &c.

Do the material particles work intelligently towards the formation of the organised machine? As we have no evidence of their doing so, and as the phenomena presented by their action appears merely mechanical, entering into certain combinations under certain circumstances over which they have no control, these compounds being again decomposed when certain other conditions are presented,—It is therefore necessary to look for some medium possessed of a unity such as may produce this harmony which exists in the working of the organism. Such a *unity* may be looked for either in the great First Cause from whom all effects are primarily derived, or in that immaterial element residing within the organism itself.

It seems to me, that to suppose the Creator to be the immediate agent in the organisation of the body, involves a supposition which we are hardly entitled to admit,—viz., that the inherent properties or tendencies of the material particles were not sufficient for the purposes they were intended to serve. It appears more reasonable to suppose that organisation is the result, not of a direct interposition on the part of the Creator, but of what may be termed an unconscious involuntary action of the psychical element upon matter; that it is the result of laws impressed upon each as it came from the hands of the Creator; and therefore we are not required to suppose any changing of the natural tendencies of the material particles, —the tendencies exhibited by matter in the formation of an organism being, as it were, latent so long as it does not come into contact with that peculiar something which we call a psychical essence. The intimate relation of the nervous system to the psychical element, and, at the same time, to the nutritive processes of the organism, together with the undoubted fact, that a psychical act or influence is capable of producing a physical effect, lead to the same conclusion; and, indeed, one cannot conceive a more natural supposition than that the formation of the body is regulated by that *immaterial unity* for the manifestation of which it was originally destined.

Organisation may be said to result from the exertion of a certain form of force inherent in the ultimate nature of the psychical principle upon material particles with which it is brought into certain relations, from which originates a series of complex chemico-physical processes, the direction and limits of which are so regulated as to produce a structure of a definite shape, such as may be completely adapted to the form or grade of psychical manifestation which is destined to occur, and to its place or sphere of action. The *morphological* *characteristics* of each species are no doubt due to peculiarities in the ultimate constitution of the material structure with which the psychical element comes into connection, as well as to differences in the *kind* and the *degree* of the action which this element is capable of exercising upon it.

An organism only exists for, and can only be produced by, the manifestation of a psychical or immaterial element.

Thus, on the ground that the vegetable is organised,—*i.e.*, presents those same phenomena of cell development and multiplication which the animal organism does,—I am led to hold that it, or its members, possess an immaterial individualising element.*

Again, the great advance which has been made within a comparatively recent period in vegetable physiology, more especially the demonstration of male and female reproductive structures in the "Phanerogamia," and of moving filaments in the "antheridia" of the "Cryptogamia," and the researches which have been made in vegetable embryology, have brought to light so much analogy between the plant and the animal as to leave us in no doubt that they are produced according to one primary developmental law; and as it were unphilosophical to suppose that the teleological principle accompanying this morphological law is not correspondingly uniform,—in fact, as the abstract primary meaning of an *organism* must be the same in all cases,—it may be concluded that, as in the higher animal organisms, including man,† the

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* Professor Goodsir, in treating of "Life and Organisation," refers to the plant as follows:—"We are quite entitled to state, as a legitimate hypothesis, that in every individual plant there is an indwelling psyche; more simply endowed than that of the lowest animal; specific for each species of plant, and therefore incapable of further evolution; never manifesting itself in psychical acts appreciable to us; and performing only the lowest function of the animal psyche, constituting the psychical form in the presence or midst of which the organisation is co-ordinated." I have here to acknowledge Professor Goodsir's kindness in having allowed me to make the above extract from his lecture on "Life and Organisation," delivered before the Royal Medical Society of Edinburgh, and as yet unpublished.

† In man, the body is organised primarily with reference to that *psychical* element of his constitution by means of which (through the body) he is brought into relation with the external world.

By the *spiritual* element of his constitution, he is brought into special relaprimary purpose served by the body is the manifestation of a psychical element, so, in the vegetable organism, is the material structure designed for a like manifestation. If the plant be morphologically comparable to the animal, I cannot but believe in its possession of an immaterial essence.

It may, however, still be objected, that the apparent deficiency of a nervous system in the vegetable organism constitutes a difficulty in our conception of the plant as a medium of psychical manifestation. It is indeed true that in the higher organisms psychical manifestations occur through the medium of a nervous system, and it is equally true that, so far as has been observed, no such system exists among vegetable organisms; but it must not thence be supposed that these have no psychical element to be manifested. In the animal kingdom it is observed that as we descend the scale, we find that those systems which, in the higher organisms, perform their distinct functions, become gradually less and less differentiated, until at last we find all the phenomena of animal life manifested in organisms whose bounding membrane consists of a single cell-wall, where the processes of digestion, absorption, circulation, respiration, and reproduction are carried on without any of the complex special organs which occur in the higher forms. Need we therefore suppose the nervous system to form an exception to this rule? Is it not more consistent to suppose, that a special nervous structure is *necessary*, not for psychical manifestation in the abstract, but only for the higher stages of that manifestation in particular?

The tissues of the vegetable individual may be easily conceived of as capable of receiving or transmitting impressions for the regulation of the functions of the organism (the most complex form of nervous system is indeed nothing more than a mass of peculiarly developed cells); and that this power of

tions with the Deity, and is rendered capable of observing the workings of his internal or mental world.

This spiritual element stands, as it were, in a secondary relation to the organised matter.

As a medium of relation or of external manifestation, *the body and "psyche" collectively*, may be said to bear to the "*pneuma,*" a relation analogous to that which the *body* bears to the *psyche.*

transmitting impressions is diffused generally throughout the substance of the vegetable organism, is rendered probable both from the apparent want of a structure specially developed for that purpose, and from the currents of electricity* which seem to pervade its tissues.

Lastly, when we consider the almost insensible gradation in the degrees of psychical manifestation exhibited by the various animals as we descend the zoological scale, and the merging, as it were, of the animal into the vegetable kingdom, through such organisms as the *Diatomaceæ*, those animated cells whose position is yet hardly settled, we cannot reasonably suppose that at any particular point the psychical element ceases to exist, but are rather led to conclude that it exists throughout the vegetable as well as the animal series.

Having thus stated these various grounds for believing vegetable life to be the result of a psychical manifestation, I recur to the statement made at the beginning of this paper, with reference to the divisibility of the vegetable organism, and thence conclude that the plant consists of a series of *individual phyta* so united, and in so far mutually dependent upon each other, as to form what has been appropriately termed a "*compound organism.*"

I would now briefly consider what are the individual members of this compound organism. On this question numerous theories have been started, but I shall confine my attention to the three theories which alone seem to possess any claims to probability,—viz., 1*st*, that the *cell;* 2*d*, that the *shoot;* and, 3*d*, that the *leaf*, constitutes the *phyton* or vegetable individual.

Although the phyton in all those plants termed Thallophytes is probably unicellular,† yet there are circumstances which render it extremely improbable that the cormophyte is built up of unicellular phyta. In the first place, our power of propagating the cormophyte by detached portions is very limited, not extending farther than the shoot, which consists of a series of leaves, and consequently of an immense number of cells. This I think could hardly be the case had each cell possessed an independent vitality. Added to this, the existence of "serially homologous" members of the shoot, with such distinct differentiation of their several functions as is found in the various modified leaves, reminds us so forcibly of the serial homologies observed in the *organs* of vertebrate, annulose, and molluscous animals, or of that analogous series of *individuals* which constitute the members of the shoot in the zoophyte, as to leave little room for doubt that they belong to one or other of these categories; and thus the first theory may be considered untenable.

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* It must here be noticed, that although electric currents probably do exist in the vegetable organism, yet the conclusions of phytological electricians on this subject must be received with great caution, until we can be assured that their processes of investigation are free from sources of fallacy.

† The term "unicellular," thus applied, is not strictly correct, as in most of, if not all such individuals, there exist included secondary cells, but it may be conveniently employed to avoid a circumlocution otherwise necessary.

The second theory—viz., that the shoot constitutes the phyton—has been supported by several very eminent botanists, among whom may be mentioned Professor Braun of Berlin, whose paper in the Transactions of the Royal Prussian Academy of Sciences for 1853 contains a very able defence of this doctrine. As I would but trespass unnecessarily on your time by entering into a critical examination of all that has been adduced in favour of this view, I shall confine myself to a statement of the ground upon which I feel compelled to reject it.

There are many shoots which have no natural conclusion of their development, and which, at whatever period they may be observed, invariably present provision for further extension in the shape of what is not very correctly called a terminal bud. As the development of these shoots is never observed to come to a definite termination from the continued progressive evolution of new leaves at their extremity, they cannot be said to undergo at any time a natural death. To meet this difficulty, Professor Braun is led to deny the universal occurrence of death among organised beings. On an observation of Schleiden's, that "the idea of individual life necessarily demands as its characteristic the individual death already conditioned in the organisation itself," he remarks, that in many respects this statement possesses no general truth, because, says he, "for the very reason that natural death is the result of a determinate conclusion of the development, those shoots (vegetable individuals) which have no such conclusion frequently undergo no death at all, except that of some of their parts; but this is a concomitant of animal life itself (casting of the skin, moulting, and other organic changes in the body)."*

Throughout the animal kingdom, wherever there have been opportunities for observation, evidence is abundant as to the inevitable occurrence of death to each individual, and it is not easy to see why it should not be equally the case among plants which otherwise present so much analogy to the members of the animal kingdom. The fact that every species is provided with arrangements for the reproduction of its kind, seems to me of itself sufficient evidence of the law of universal death. It appears absurd to suppose that the reproductive apparatus serves as a counter-agent to those causes external to the organism which produce casual death. This reproductive structure must, like all the other organs of the body, have a primary reference to the organism itself, to the laws to which it is subject. The reproductive organs can have primary reference only to a law which tends to exterminate the species, and which operates within the organism itself; and that such a law of death exists in the animal kingdom there can be no doubt. If such be the meaning of the reproductive organs in the animal kingdom, it were unphilosophical to suppose that, as we enter the vegetable kingdom, the phenomena of reproduction should have there acquired an entirely different signification.

With regard to the third theory, that the leaf is the phyton, it may be remarked, in the first place, that it is free from the objection which has just been made to the individuality of the shoot; and, secondly, the "metamorphoses" of the leaf in performance of the protective, respiratory-nutritive, and reproductive functions of the organism, present such unmistakeable analogies to similar changes in the undoubtedly individualized polypes of the compound zoophyte, as to leave the observer in little doubt as to the true nature of the leaf.

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* See translation in "Annals of Natural History," vol. xvi., p. 336, and the original in the Transactions of the Royal Prussian Academy of Sciences for 1853, p. 55.

Professor E. Forbes, in his beautiful sketch of the morphology of the reproductive system of the Sertularian zoophytes, has shown that the polypes which, by successive gemmation in definite order, form a branched plant-like coralline, do at certain parts form reproductive vesicles, which result from the coalescence of the polype-cells composing an axis, and often accompanied by a shortening of that axis. He has shown that these polypes occasionally present abnormalities very similar to those observed in plants: one case in which branches, bearing regular cells, seemed to spring out of vesicles, and to be changed in some instances into vesicles again; and another, where the branch was partially transformed into an ovigerous vesicle, whilst the polypes of the basal extremity retained their normal nutritive character.

The shoots of these zoophytes are perfectly comparable to plant shoots. In the greater number of Sertularians, secondary shoots are mere repetitions of those from which they spring. The polype individuals, on the other hand, do not present the slightest analogy to vegetable shoots; their development is perfectly definite, and they resemble leaves in springing from the axis at regular intervals, being opposite, alternate, or uniserial in their arrangement. That these arrangements are, like those of the leaves in the plant, modifications of a spiral evolution of the members of the shoot, may be gathered from an examination of the more regularly developed compound Actinozoa.

The formation of ovigerous vesicles, as described by Forbes, presents a close analogy to the frequent coalescence of the members of the vegetable shoot in forming the floral envelopes, and fruit.

In conclusion, I would state my reasons for differing from Professors Steenstrup, Owen, and Forbes, in their determination of the carpel as the female generative phyton, and from the two first in their pronouncing the stamen to be the male phyton.

Adolphe Brongniart, in his papers upon vegetable monstrosities, has, I think, completely established the fact, that the seed or ovule of the plant is a modified leaf. The female generative phyton would thus be found, not in the carpel, but in the ovule. M. Brongniart, however, has supposed that, while the seeds proceeding from central placentæ are the modified leaves of the prolonged floral axis, those produced on parietal placentæ are merely modified lobes or denticulations of the carpel. In a small notice relating to this subject which I submitted to the Society last year, I argued that it was "unphilosophical to suppose that structures, so manifestly similar to each other in their general anatomical details, and which are identical as regards their physiological function, as the ovules throughout the higher Phanerogamia, should be specific formations in one set of plants, and not so in another." The ovules in *Primula sinensis* have been shown by M. Brongniart to be manifestly modified leaves; and without doubt the ovules of Delphinium have a similar morphological constitution.

I am much inclined to believe that there exist in reality two modes of placentation: the one where the ovules are produced by a process of gemmation from the carpellary leaves (*parietal*); the other where the ovules spring from the prolonged floral axis (*central*). The placenta itself (whether central or parietal) is the axis formed by, or belonging to, the seeds or female generative leaves.

That ovules may be produced upon true parietal placentæ appears strongly confirmed by some curious monstrosities in the flowers of *Salix Andersoniana*, described by Mr Lowe in the Society's Transactions, vol. v., p. 113; where the stamens, more or less united by their filaments, were metamorphosed into carpels, the ovules being produced on the margins of the modified anther. I have myself, within the last month, observed in the flowers of a Salix, which I obtained at Arniston, near Dalkeith, an abnormality very similar to Mr Lowe's, excepting that there was no junction of the filaments of the two modified stamens. That these rudimentary ovules, produced upon the modified anther-lobes, and separated from the floral axis by the long filament of the stamen, should be developed from that axis, or a prolongation of it, is an idea which is hardly admissible. The placentation in this case must, I think, be called parietal.

Much is yet required before we can arrive at a satisfactory determination of the true relations which the *fruit* of the flowering plant bears to the *reproductive vesicles* of the compound Hydrozoön. We must obtain a deeper insight into the precise nature of the structures concerned in the formation of both before any minute comparison can become practicable.

Those vesicles, however, in Laomedea, Campanularia, &c., which Professor Allman has described under the name of "capsular compound gonophores,"[*] appear to present a close analogy to the fruit of the plant. The medusoid "sporosacs" (when female) are comparable to the seeds of the plant. The "blastostyle" of Dr Allman may be compared to what botanists have called the "placenta." The "capsule," by which the blastostyle, with its medusoid gemmules, is inclosed, corresponds probably to the carpellary whorl of the flower.

The "nucleus" of the seed must, I believe, be considered as the specific reproductive organ, or ovary. Whether this be analogous to those glandular papillæ on the stipules in the Cinchonaceæ, "nectaries," &c., is a question well worthy of attention.

The "embryo-sac" (in "angiosperms") corresponds to the ovum of the animal. The development of several germinal vesicles in this vegetable ovum is not without its parallel in the animal kingdom.[†]

With regard to the *male* phyton, I believe that there are sufficient grounds for the belief that it appears in the Phanerogamia as the *pollen-cell.* In the first place, the continuation for many months of the life and growth of the pollen-cell after its discharge from the anther, in the Coniferæ, would appear to indicate that this was the case, although an organic connection with the tissues, through which its tube penetrates, is conceivable without supposing the pollen-grain to be necessarily individualized. 2*dly*, Upon tracing the pollen-grain and its homologues from the "Phanerogamia" into the "higher Cryptogamia," we find a gradual exaltation of the development of these fertilizing structures, until, on reaching the mosses and their allies, we find them occupying the position of modified leaves. In the "angiospermous Phanerogamia," we find the pollen-cell filled by a viscid fluid, along with starch and oil-globules; besides this, there is nothing apparent. In "gymnosperms," among the Cupressineæ, cellules appear to be formed in the pollen-tubes during fertilization.* From this first indication of increased elaboration of the contents of the pollen-cell we are led to those pollen-like cells, the "small spores" of the Lycopods and their allies, the cellular contents of which appear to resemble, in all essential particulars, the sperm-cells of the animal organism. In the Spermatozoids of the "higher Cryptogamia," we have a perfectly animal-like elaboration of the fertilizing secretion.

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[*] Transactions of the Royal Society of Edinburgh for 1858; also in Edinburgh New Philosophical Journal, April 1858, p. 295.

[†] Leydig's Lehrbuch der Histologie, p. 551.

In ferns we find the development carried a stage farther; the structure containing the sperm-cells is no longer composed of a single cell, but is a multicellular, although very simple structure. In the Equisetaceæ we have a still greater development, leading us, without any abruptness, to the club-shaped cellular sacs containing sperm-cells, which are produced by the mosses and their allies, and which are often seen (*e.g.*, in Mnium) clustering at the end of a shortened axis, just as the female reproductive leaves do in the flowering plants.

Again, the apparent substitution of ovules for pollen upon the modified anther-lobes of the salices, observed by Mr Lowe, and subsequently by myself, seems to indicate that the ovule and the pollen-grain are interchangeable, and therefore homologous. The gemmiparous condition of the anther in house-leek, which has sometimes been observed, also favours this view. For these reasons I cannot agree with Professor Owen when he says—"The spermatozoön of the male Aphis answers to the pollen-filament of the male leaf or 'stamen.'"†

The pollen-cell must, I think, be considered as the male phyton; and I am very much inclined to compare it, with its long tube, to those minute rudimentary-looking males with long proboscidiform penes which occur in the Cirrhipedia.

If I be correct in the view I have just taken of the male and female individuals in the cormophyte, it is manifest that the names at present connected with these structures are wholly inapplicable. The terms "ovary," "ovule," "placenta," &c., are, indeed, worse than meaningless, as they convey erroneous impressions, whatever be the theory adopted of vegetable individuality. I would propose, therefore, to term the female generative phyton ("ovule" in angiosperms; "corpuscle" in gymnosperms; "archegonium" in lycopods, ferns, mosses, and their allies) *Theleophyton* (from θῆλυς, female, and φυτόν, plant). The "placenta," whether central or parietal, may be called *theleophytal axis*. The male phyton I would call *Arrenophyton* (from ἄῤῥεν, male). The cotyledons may be termed *Protophyta;* the leaves, *par excellence, Phyllophyta;* the sepals, *Sepalophyta;* the petals, *Petalophyta;* the stamen, *Stematophyta* (from στῆμα, a stamen); the carpels, *Carpophyta*. The termination of the theleophytal axis, called stigma, is probably composed of a number of rudimentary phyta, which, by their viscid secretion afford attachment, and probably nourishment, to the pollen-cells, and which may be termed *Stigmatophyta*.

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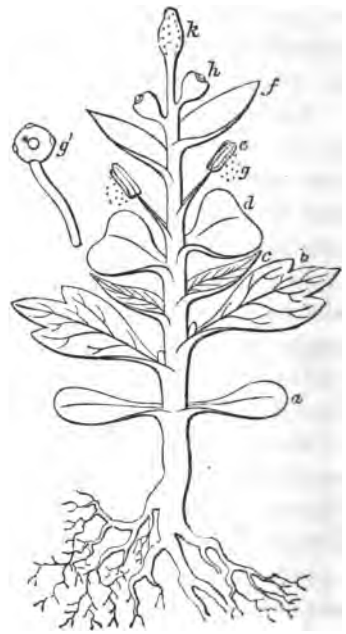
* Griffith and Henfrey's Micrographic Dictionary, p. 518.

† Owen, Parthenogenesis, p. 59.

Scheme of a Dicotyledonous Phanerogam.



a. Cotyledon, or *Protophyton*.
b. Leaf, or *Phyllophyton*.
c. Sepal, or *Sepalopyhton*.
d. Petal, or *Petalophyton*.
e. Stamen, or *Stematophyton*.
f. Carpel, or *Carpophyton*.
g. Pollen-grain, or *Arrenophyton*.
g'. Do. do. with tube; enlarged.
h. Seed, or *Theleophyton*.
k. Stigma, composed of *Stigmatophyta*.

On the Metamorphoses of Orthopterous and Hemipterous Insects. (Supplementary to Remarks on Leaf Insect, Phyllium scythe, *published in January,* 1856.) By ANDREW MURRAY.*

It may be in the recollection of some of my readers that about two years ago, in pronouncing the funeral oration of the leaf insect (*Phyllium scythe*), which had passed its life in the Royal Botanic Gardens here, I took advantage of certain particulars which had been observed in its structure and mode of growth, to submit to the public some new views as to the metamorphosis of hemipterous and orthopterous insects.

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* Communicated to the Royal Physical Society, 24th February 1858.

The course of life of these insects is to emerge from the egg in the shape of a six-legged insect, resembling the perfect insect in form, but without wings, and with different antennæ; and this stage had hitherto been held to correspond to the caterpillar or grub state. On changing its skin, the animal made an advance in resemblance to the perfect insect, but had still only the rudiments of wings. This was conceived to correspond to the pupa state; and the insect in that state was called an *active* pupa. The third and last change of skin revealed the perfect insect provided with wings.

The view which I suggested was, that both the larval and pupal stage were passed in the egg, and that the six-legged, jointed-legged creature, resembling the perfect insect, but without wings, which we were in use to call the larva and pupa, was only an undeveloped perfect insect, which underwent changes of skin towards the termination of its life, instead of at the commencement, as is the case in those insects which do not undergo what was called a semi-complete metamorphosis.

It had been previously observed (*Owen*), that in its earliest stage the insect passed a portion of its life in the egg, in the form of a grub; but this was rather looked upon as an early phase in the development of the creature, and that the larval and pupal stages were still passed in the active state to which I have referred.

Further observations have confirmed me in the view which I then announced; and without going into any argument on the subject (for which I would refer to my former communication), I would now wish to put on record the stage of proof at which I conceive the different facts which have been before and since observed leave the question.

On examining the egg of the *Blatta* (which is a compound egg formed somewhat like a broad pea, in which spaces are partitioned off transversely for the reception of the different young insects), we find at an early stage a row of unmistakeable grubs, ten or twelve in number, packed closely up, filling these partitions. I possess a specimen where the grubs have apparently reached their full growth, for they fill the whole space, and are nearly a quarter of an inch in length.

I possess another egg, on opening which I found only two insects, but they had no longer the grub form; they were small, wingless *Blattæ;* one was perfect and fresh, the other somewhat injured; they were probably the last survivors of their brothers and sisters, whom they had no doubt devoured, for the egg, although ready to open, had never given egress to any of its inmates. I am satisfied of this, from the position and condition of the eggs. They were taken from the corners of the eyes and behind the ears of a rude idol-like figure which was sent to me from Africa. When the insect had laid them there, it had plastered them all over with a cemented coating of chopped wood or straw, like a cocoon; and after this had been done, the whole figure had been rudely painted by the natives, and these cases were covered with the paint. No insect could have emerged without breaking through the case and the paint, which were both uninjured. I presume, at a certain stage on their passage homewards, the cold had killed them, and I found the mummied remains as I have described.

In my former paper on this subject, I think I distinctly showed the existence of a cocoon found in the egg of the leaf insect; and combining these particulars, we have the following chain of facts :—

1. The grub in the egg.
2. A cocoon in the egg, containing the unwinged, imperfectly-developed insect.
3. The unwinged, imperfectly-developed insect in the egg, free from the cocoon, and ready to emerge.

These facts appear to form a pretty secure basis for holding that the course of metamorphosis, in this class of insects, does not differ from that in the other classes, except that the grub stage and pupa stage are passed in the egg, instead of in the open air,—and also probably with this qualification, that the usual changes of skin, which in other insects take place in the grub stage, do not here take place at that period; but, as it would appear, for some reason which we have not yet discovered, that it is essential to the economy of insects that they should cast their skins a certain number of times, the orthopterous and hemipterous insects perform this necessary step after passing from the pupa state, instead of before entering it.

There is another point bearing upon this question which I did not sufficiently press in my former paper. In it I stated that in the leaf insect the sexual organs did not appear to be fully developed until the last change; and I endeavoured to account for this as being analogous to similar changes in other animals on reaching the age of puberty. But I now see reason to modify this expression of my views, or at least to limit this non-development to the younger stages of these individuals, as, for instance, before they have changed their skin at all. In such very young individuals the sexual organs may not be, and probably are not, fully developed; but I am now satisfied that they are so, at least, before the insect reaches its last and winged state.

I now know, both from personal observation and from the testimony of other observers, that perfect winged Hemiptera have been found coupling with incomplete apterous individuals; and not only so, but two incomplete apterous individuals have been found coupling together.

Such a fact would seem to preclude the necessity of saying more. It looks like *probatio probata.* Notwithstanding this, further light may still be thrown upon it by careful dissections of the sexual organs in fresh specimens of this order of insects in their different stages;—an investigation which I would invite such of my readers as are interested in the subject to undertake, as being likely to lead to discoveries and information of a more extended nature than the mere question now under consideration.

On M. S. De Luca's Claim to be the Discoverer of the Non-presence of Iodine in the Atmosphere, in Rain-Water, and in Snow. By STEVENSON MACADAM, Ph.D., F.R.S.E., Lecturer on Chemistry, Edinburgh.*

A communication, entitled "Recherches sur l'Iode Atmospherique," has lately been published by M. S. De Luca, in the "Journal de Pharmacie," in which the author details the results of a number of experiments conducted by him, in reference to the general distribution of iodine, and in which he lays claim to be the first discoverer of the non-presence of iodine in the atmosphere, in rain-water, and in snow. Had M. De Luca confined himself to the recital of the apparatus and re-agents employed by him in his researches, and to the simple expression of the negative results obtained by him, I would not have considered it necessary to ask the Botanical Society of Edinburgh to allow me to protest against his non-recognition of the earlier labours of others; but since he has appended to his memoir an extract from a communication by M. Cloez on the same subject, in which priority of discovery is yielded to M. De Luca, I think it due to myself, that the following statement of facts should be laid before the Society:—

At the meeting of the French Academy of Sciences on 5th May 1851, M. Chatin communicated a memoir, entitled "Presence de l'Iode dans l'Air," which was published in the "Comptes Rendus" of same date, and in which the author stated his opinion, that he had experimentally demonstrated the presence of iodine as a natural constituent of atmospheric air, rain-water, and snow. In the early part of 1852, I commenced a series of experiments upon this subject, with the view of being able, if possible, to verify the observations of Chatin; and on the 22d June of that year communicated to the late Professor Jameson the results obtained by me up to that time, and which were published in the "Edinburgh New Philosophical Journal," issued on the 1st July. In that paper it is distinctly stated that the air and rain-water experimented upon had yielded no iodine. The investigation was, however, proceeded with; and on the 8th July I communicated to the Botanical Society of Edinburgh a paper "On the Presence of Iodine in Various Plants, with some Remarks on its General Distribution," in which it is recorded that 4000 cubic feet of air, and successive quantities of rain-water collected at Edinburgh, and at Unst in the Shetlands, had failed to indicate the presence of the faintest trace of iodine. This paper was published in the "Chemical Gazette" (1852), in the Transactions of the Botanical Society, and elsewhere; and the substance of it, with the addition of the records of still further experiments, was published in the "Edinburgh New Philosophical Journal" for 1st October 1852. It is there stated that 100,000 cubic feet of atmospheric air had been passed through an apparatus fitted up to arrest iodine and iodides, and "that in the large volume of air subjected to examination there had not been an appreciable quantity of iodine." Twelve gallons of rain-water were likewise examined for iodine, "but without giving a positive result." The examination was continued; and on the 18th April 1853, I read a paper before the Chemical Society of London "On the General Distribution of Iodine," in which reference was made to my previous researches, and other experiments detailed, in which 12 gallons, and even 36 gallons of snow-water "did not exhibit the slightest indication of the presence of iodine," and that "the negative results of these experiments lead me to believe, that in the air, in the rain-water, and in the snow employed by me, there was not an appreciable quantity of iodine;" and that I differed "from the views expressed by Chatin in reference to the atmospheric distribution of iodine." It is likewise mentioned, that "so far as regards the process adopted by myself, it is worthy of remark that Thenard, in commenting upon the researches of Chatin, recommends that the metals most susceptible of being iodized should be exposed for some time to the action of the air. Some months previous to this suggestion being read to the Academy of Sciences, I had used iron and lead in the search for iodine; and ten days prior to the date of Thenard's paper, a report of some of my experiments was published in the 'Edinburgh New Philosophical Journal,' in which the use of the metals was clearly stated." ("Quarterly Journal Chem. Soc.," July 1854.) In September 1854, the foregoing researches formed part of a memoir "On the Distribution of Iodine in the Mineral, Vegetable, and Animal Kingdoms," read by me before the chemical section of the British Association, at the meeting in Liverpool, and which is published in the Transactions of that body, and in the "Pharmaceutical Society's Journal" for December 1854.

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* Read before the Botanical Society of Edinburgh on 10th June 1858.

Besides the publication in this country, full abstracts of these papers appeared in the "Jahresbericht Chemie" (edited by Liebig and Kopp) for 1852 and 1853; in the "Journal de Pharmacie" for April 1853; and in other continental journals.

Now, the researches of M. S. De Luca were first noticed in the "Journal de Pharmacie" for October 1854; and the details of his experiments, accompanied by a positive statement as to the non-presence of iodine in the atmosphere, in rain-water, and in snow, did not appear till the numbers of the "Journal de Pharmacie" for December 1857, and January 1858. In these latter numbers we find the following:—

"Voici maintenant les experiences faites directement sur l'air, sur l'eau de pluie, et sur la neige.

"*a.* Le 30 Decembre 1852, j'ai monté dans une Chambre de la rue de Lacepédè un appareil disposé de la maniere suivante: . . . . . cet appareil a fonctionné depuis le 1er Decembre 1852 jus qu'an 4 du mois de Juin suivant, avec quelques jours d'interruption. . . . . . .

"*b.* Pendant que l'appareil précédent marchait j'ai fait d'autres expériences sur l'eau de pluie et sur la neige. . . . .

"*c.* Dans le mois de Fevrier 1854, depuis le 17 jusqu'au 23 une certaine quantité de neige est tombée avec quelque interruption dans Paris. J'ai profité de cette occasion pour rechercher l'iode dans la neige." . . . .

And in detailing the remaining experiments on rain-water, M. De Luca refers to

"1° Eau recueillie du 24 Juillet au 30 Septembre 1853.

"2° Eau recueillie du 1er au 31 Octobre 1853.

"3° Eau recueillie du 1er Novembre au 31 Decembre 1853.

"4° Eau recueillie du 1er Janvier au 1er Mars 1854.

"5° Eau recueillie du 2 Mars au 31 Mai.

"6° Eau recueillie du 1er au 30 Juin.

"7° Eau recueillie du 1er Juillet au 3 Août 1854."

It will thus be apparent that M. De Luca did not *commence* his experiments till the 30th December 1852,—viz., six months after my preliminary note to Professor Jameson had appeared in the "Edinburgh New Philosophical Journal," and three months after my principal researches had been published in detail in the same journal; and he *ceased* to collect material for his researches on 3d August 1854, immediately after which (October 1854) he announced, very shortly and vaguely, the negative results he had obtained. It was thus two years and three months after my preliminary statement, and exactly two years after my principal memoir had been laid before the scientific world, that the researches of M. De Luca were so far advanced as to enable him to record even a brief preliminary statement on the subject. Before this time, my researches had been laid before the Botanical Society of Edinburgh, the Chemical Society of London, and the British Association for the Advancement of Science; and full abstracts of these papers had appeared in many journals published in and out of Britain, including Liebig's and Kopp's "Jahresbericht Chemie," and the "Journal de Pharmacie." Moreover, the statement originally experimentally demonstrated and published by me, as to the non-presence of iodine in the atmosphere, had, previous to the publication of M. De Luca's researches, been corroborated by the labours of M. Casaseca of Havanna ("Comptes Rendus," 9th August 1853), who failed to discover the least trace of iodine in the rain-water which fell in the island of Cuba; and Dr Lohmeyer ("Comptes Rendus," 24th August 1853), who could not find iodine in the atmosphere near Göttingen. Indeed, seven months before M. De Luca published any of his experiments or deductions therefrom, my researches had been referred to by M. Chatin in his review of the labours of MM. Casaseca, Lohmeyer, and myself, which was published in the "Journal de Pharmacie" for March 1854.

It will thus be seen, if priority of publication is to be held conclusive as to priority of research, that M. De Luca cannot even rank second in order in refuting the doctrine of the atmospheric distribution of iodine, but will take the fourth place,—that is, after MM. Casaseca and Lohmeyer.

I may be allowed to state, that whilst repelling the claim of priority on the part of M. De Luca, I have no wish to refer in any way but praise of the processes adopted and the apparatus employed by him in his researches, and the evident care and accuracy of his manipulation; and, at the same time, I have also to express great admiration at the novel and thoroughly satisfactory experiments of M. Cloez on the same subject, which were read before the Institute de France, on the 23d May 1857, and are published in "L'Institut" for 10th June 1857. The conclusions he arrived at are likewise corroborative of the original statement made by me in 1852, that an appreciable amount of iodine or iodides could not be detected in the atmospheric air, in rain-water, or in snow.

REVIEWS AND NOTICES OF BOOKS.

The Geology and Extinct Volcanoes of Central France. By G. POULETT SCROPE, M.P., F.R.S., &c. Second Edition, enlarged and improved, with Illustrative Maps and Panoramic Sketches. 8vo. London, J. Murray, 1858.

This is the second edition of a work, more than thirty years old, relating to one of the most progressive sciences, and to a region which may be fairly said to have become ten times more accessible than it was when Mr Scrope first wrote. Yet it is singular that this book has not been superseded; and consequently the author is fully entitled to reproduce it, with little essential change, for the benefit of a generation younger than that for which it was originally composed.

This could not have occurred in any but a treatise on *Volcanic* Geology.

Few geologists of the present day, it may be presumed, have not heard of Mr Scrope's "Geology of Central France," because it is extensively quoted in Sir C. Lyell's and other popular books. On the other hand, it is most likely that only a few comparatively have ever seen it. The elaborate illustrations and high price of the first edition have rendered it a scarce book. As long as we can recollect, and for a number of years it has been totally unpurchasable. The fortunate possessors of that scarce book will still prize it above the second edition, which at less than half the price, and with additional matter, has no pretension in the artistic felicity of the illustrations to vie with the original beautiful atlas, which must be considered as a labour of love by a gentleman of independent fortune, and an excellent artist, not as an ordinary bookselling speculation. Not that Mr Murray has not done fair justice to the present volume. It is even elaborately illustrated by maps, woodcuts, and panoramic views. The maps are in some respects superior to the former ones; and that executed by Messrs Johnston after Dufrenoy's and Elie de Beaumont's geological map of France is an admirable specimen of colour-printing. But the panoramas are now condensed horizontally within a compass suited to be conveniently folded into the volume, instead of being expanded in the true proportions of the vertical and horizontal scales. They want the life and vigour of *fac-similes*. The gradations of distance are imperfectly rendered, and the colouring, where it is introduced, is inferior to that of the originals. But then we must recollect that the Atlas of the first edition was an expensive luxury. It was almost the earliest attempt to represent the true outlines of scenery, of which the very forms are full of geological meaning, in combination with a system of slight tinting which meaningly expresses the mineralogical composition of the localities without materially detracting from the truth of the picturesque. The same idea has since been followed out in Sir R. Murchison's costly and beautiful volumes.

Mr Scrope in his new preface gives us an account of the circumstances of his original publication. Having passed two winters (1817-19) in Italy, he became deeply interested in the volcanic phenomena of Vesuvius, Etna, and the Lipari Isles. After his return home, while pursuing the study of geology under Dr E. D. Clarke, and in conjunction with Mr Sedgwick, he was naturally led to criticise the Wernerian doctrines as to the origin of the secondary trap rocks, such as basalt and clinkstone; doctrines which he describes as being at that time completely in the ascendant. He had naturally been led by his studies in Italy to the opinion that all these rocks were the product of volcanic, not of aqueous deposition, and he fortunately bethought himself of passing his next holiday in Central France. He accordingly spent several months there in 1821, collecting the information contained in this volume. It was not, however, his first publication. A thin octavo, entitled "Considerations on Volcanoes," appeared in 1823, the aim of which was in some respects more ambitious. Many interesting facts and judicious reflections were overlaid by a large amount of theoretical speculation, not always expounded to advantage. Mr Scrope now very candidly admits the defects of his maiden production, and regrets that he had not published first a more strictly descriptive work. This was soon corrected; for in 1826 he gave to the world the work on Central France, the whole gist of which lies in the elaborate fidelity of the descriptions and the plates. For this, and in some degree for his former work also, Mr Scrope lays claim to the merit of having established two doctrines previously imperfectly realized: *First*, The efficacy of ordinary natural causes still in operation to explain many geological revolutions; *secondly*, The igneous origin of all the class of trap rocks.

With regard to the first of these—the study of past changes in the light of present ones, and the vast demands which must be made for time in explaining the mutations of the globe—Mr Scrope's claim appears to us to be well founded. And it is reasonable to believe that Sir C. Lyell—then a student in the science in which he is now so great a master—had his mind strongly directed to that phase of geological truth which Mr Scrope in both his works ably illustrates. Indeed, Sir C. Lyell's earliest essay in geology is stated in the preface before us to have been a review of Mr Scrope's writings in the "Quarterly" for May 1827. Every reader of Sir C. Lyell's books must remember how many of his illustrations were drawn from the interesting volcanic phenomena of Central France, especially in the earlier editions of his "Principles."

As to Mr Scrope's second claim, that of having triumphantly extinguished the belief of the aqueous origin of trap, which he describes as "then [1823] predominant in Germany, at Edinburgh, and in several other quarters, where it was considered heresy to dispute the precipitation from some archaic ocean of all the crystalline rocks,"* but which "has since that date never held up its head,"† we must be allowed to say that our esteemed author makes his thunder rather too loud. Because a single professor in Great Britain, who was also of Edinburgh (the tenacity of whose adhesion to doctrines which he had once held on any subject was to the end of his life a striking individual characteristic), because, we say, the respectable Jameson held out in 1823 the forlorn hope of the Wernerian creed, undeterred by the incalculable superiority of numbers who, even in his own town and for twenty or thirty years previously, had been loudly proclaiming to all who would listen to the truth of the contrary proposition, can it for a moment be seriously maintained that the aqueous origin of trap was a "predominant doctrine" in Great Britain generally, or at Edinburgh in particular? As regards Edinburgh, was it not in the very foremost rank in disabusing the public mind of those antiquated prejudices? Was it not the Huttons, the Playfairs, the Webb Seymours, the Halls, the Hopes, the Allans, and the Gregory Watts, who fought the battle of the vulcanicity of trap, and of granite too (which was a step farther in advance), long before Mr Scrope broke stone with hammer, or clambered the steep sides of the Puy de Dôme. Nor was it otherwise on the Continent. Germany has ever a large band of philosophic dogmatists who adhere to long exploded theories in physics and natural history, and hand down from age to age the time-honoured doctrines of some popular professor. But Mr Scrope admits his full knowledge of the admirable and vigorous letters of Von Buch, who, visiting Auvergne in the first years of the century, had entered as emphatic a protest as man could do against the inconsistent absurdity of Wernerianism. Whilst France, often slow to take up the clue of discovery from another country, had, ever since the middle of the eighteenth century, proclaimed the vulcanicity of the basalts of Auvergne and the Vivarais; and after that time a series of writers appeared in succession (as Mr Scrope indeed cites in his third chapter)—the St Fonds, the Desmarests, the Montlosiers, and the Ramonds, whose errors, such as they were, lay on the side of ultra-Plutonism, and whose works may almost all be consulted at the present day as containing valuable information on the volcanic and trappean formations of Central France. Mr Scrope's works, therefore, while they have the unquestioned merit of specially directing the notice of English geologists to a region then (and even now) little known to tourists, could not, from the then advanced state of public opinion on this subject, do more than bring the Huttonian argument to a triumphant close, and finish the rout of the already scattered remnant of the Wernerian phalanx.

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* Scrope, p. 142, *note*.

† Ib. preface, p. ix.

Having thus, by this single criticism, rather on Mr Scrope's historical than geological inaccuracy, discharged a duty which devolves on us, alike as journalists and Scotchmen, we have nothing farther but commendation to bestow upon his labours.

Let us turn, then, to this country of Central France, which still continues, as has been said, far too little known to travellers. It is, for the most part, a rough, wild, and unfertile region, occupying no insignificant portion of the heart of France to the south-west of the town of Lyons. From its elevated plateaux several important rivers take their rise, especially the Loire and the Dordogne. The basic formation of the whole district is granite or gneiss, and through this rock, for the most part, have appeared those volcanic outbursts which give so peculiar an interest to the country.

Five different volcanic centres may be mentioned as geographically and geologically distinct: 1. The Puys of Clermont, or the Monts Dôme; 2. Mont Dore; 3. The Cantal; 4. Le Puy (in the ancient department of the Velay); 5. The Vivarais or Ardêche.

Of these districts, the first two (which are conterminous) are the best known and most accessible. Clermont, one of the most picturesque provincial towns of France, at no great distance from the frequented baths of Vichy, lies very near the base of the Puy de Dôme, which is the culminating point of the first volcanic group. It is surrounded by those remarkable plateaux of basalt, curiously intermixed with sedimentary rocks, which strikingly recall the trappean formations of our own Hebrides.* They are, however, intimately associated with streams of basaltic lava, evidently of more recent date, which pour down the slopes, and line the beds of the valleys precisely as may be seen on the flanks of Vesuvius and Etna. The lavas of Clermont, like those modern streams, may be traced to eruptive cones of loose red cinders, perfect in form, and on which the decomposing effect of centuries has scarcely left a trace. The very unresisting nature of volcanic dross and pumice allows the percolation of rain without the smallest corrosion, and in its cindery soil not even the lichen can attach its tiny roots: there they rise, these brick-red cones, all desolate, verdureless, and solitary, amidst wastes of black lava, where tillage will never come, where flocks will never pasture, whence the habitation of man is as effectually banished as from the wastes of Alpine snow, or the salt waves of the Atlantic. As to the geology of the district, Sir Charles Lyell has drawn an admirable picture of it in a passage which we quote:—

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* The view of the hill of Gergovia (Scrope, p. 107) strikingly recalls innumerable localities of the islands of Mull and Skye.

"We are here presented with the evidence of events of astonishing magnitude and grandeur, by which the original form and features of the country have been greatly changed, but never so far obliterated but they may still, in part at least, be restored to imagination. Great lakes have disappeared; lofty mountains have been formed by the reiterated emission of lava, preceded and followed by showers of lava and scoriæ; deep valleys have been subsequently furrowed out through masses of lacustrine and volcanic origin. At a still later date, new cones have been thrown up in these valleys. New lakes have been formed by the damming up of rivers, and more than one creation of quadrupeds, birds, and plants (Miocene, Pliocene, and Post-Pliocene) have followed in succession; yet the region has preserved from first to last its geographical identity, and we can still recall to our thoughts its external condition and physical structure before these wonderful vicissitudes began, or while a part only of the whole had been completed. There was first a period when the spacious lakes, of which we still may trace the boundaries, lay at the foot of mountains of moderate elevation, unbroken by the bold peaks and precipices of Mont Dor, and unadorned by the picturesque outline of the Puy de Dôme, or of the volcanic cones and craters now covering the granitic platform. During this earlier scene of repose deltas were slowly formed; beds and calcareous rocks precipitated from the waters of mineral springs; shells and insects imbedded together with the remains of the crocodile and tortoise, the eggs and bones of water-birds, and the skeletons of quadrupeds, some of them belonging to the same genera as those entombed in the Eocene gypsum of Paris. To this tranquil condition of the surface succeeded the era of volcanic eruptions, when the lakes were drained, and when the fertility of the mountainous district was probably enhanced by the igneous matter ejected from below, and poured down upon the more sterile granite. During these eruptions, which appear to have taken place after the disappearance of the (Lower Miocene) fauna, and partly in the (Pliocene) epoch, the mastodon, rhinoceros, elephant, tapir, hippopotamus, together with the ox, various kinds of deer, the bear, the hyæna, and many beasts of prey, ranged the forest, or pastured on the plain, and were occasionally overtaken by a fall of burning cinders, or buried in flows of mud, such as accompany volcanic eruptions. Lastly, these quadrupeds became extinct, and gave place to (Post-Pliocene) mammalia, and these, in their turn, to species now existing. There are no signs, during the whole time required for this series of events, of the sea having intervened, nor of any denudation which may not have been accomplished by currents in the different lakes, or by rivers and floods accompanying repeated earthquakes, during which the levels of the district have in some places been materially modified, and perhaps the whole upraised relatively to the surrounding parts of France." (Lyell's "Manual," quoted by Scrope, p. 213.)

The geology of the Clermont district has been most thoroughly explored by Mr Scrope. His map of it is the produce chiefly of his own labour, although that by Desmarest, by no means inferior to it, had existed, without his knowing of it, many years previously. This is the less to be regretted, as it compelled that minute attention to topographical detail which is essential to the thorough comprehension of the physical geography of any country.

II. Next in order we have the district of the Monts Dore, about 20 English miles from Clermont, from which a cinder-covered road leads amidst wild and solitary cones of volcanic dross. But as we approach the hills of Mont Dore gladder scenes open on the weary eye. Grassy hills and pine-clad valleys, all indeed on a volcanic basis, show that the usual effects of time have been produced, owing either to the remoter antiquity of the rocks, or from their more decomposable material—probably both. Trachyte is, generally speaking, an older product than basalt; it is also more ready to decompose by weathering, and the soil to which it gives rise is a more genial seat of germination. Pleasant, indeed, is the cool and green and Alp-like valley where are situated the baths of Mont Dore, where also better accommodation welcomes the traveller, inviting him to remain a day or two, than is like to be his lot during the greater part of his wanderings in Central France. For it may be mentioned by the way, that in few civilized countries is a greater amount of thorough discomfort to be met with than in the inns of the central departments, without always excepting even the capitals.

The highest point of the Monts Dore, called Pic de Sancy, rises to a height of 6258 English feet. It is composed of porphyritic trachyte.

"Connected with this by intervening ridges, rise on each side similar craggy knolls of the same substance, more or less rounded by weathering, and partly covered with vegetation. One of them, the Puy Ferrand, almost equals the Pic de Sancy in elevation. These two most prominent heights overlook, on the right and left, two deep amphitheatrical basins, one opening to the north, encirled with a range of perpendicular precipices, in which the different sources of the Dordogne unites; the other, to the north-west, forming the gorge of Chaudefour, at the head of the valley of Chambon. On the side opposite to these hollows each eminence gives rise to an inclined plane, with a gradually decreasing slope, perhaps broken at first into three or four step-like projections, one above the other, and by degrees widening as it descends into vast platforms, which, with few interruptions, reach the base of the mountain, and prolong themselves to some distance over the adjoining country. The rock which composes the platforms is, almost without exception, trachyte, and the general divergence of all the principal trachytic currents from one spot, leads us to presume them the produce of a single habitual vent occupying this central situation." (Scrope, p. 124.)

The plateaux of trachyte are thick and comparatively confined in extent, reaching not above ten miles in a right line from the centre of Mont Dore. The sheets of basalt, on the other hand, which surround and are often intermixed with trachyte, appearing at times posterior and at times anterior to it in origin, stretch in prodigious table-lands of slight inclination to distances of even twenty-five or thirty English miles. (Scrope, p. 117.) The fluidity of this rock at the period of its emission has evidently been far greater than that of the trachyte. Mont Dore presents no distinct trace of a central crater. Indeed, the general aspect of the mountain is not more regular or conical than may be observed in many quite different formations, and the arrangement of the greater part of the rocks is nearly as confused as that which may be met with in the traps of the secondary period; nor is it possible, with any degree of certainty, to refer the trachytes and clinkstones to their precise origin, or to trace the period or process of their emission. Several of the enormous effusions of basalt may be referred to scoriaceous cones on the outskirts of the group.

III. Almost immediately to the south of the Monts Dore lies the distinct and all but isolated volcanic elevation of the Cantal. This region is less known, perhaps, than any of the others, probably from its remote position, and it seems to have occupied less of Mr Scrope's attention. Its great simplicity of structure, indeed, makes it easier of comprehension. But it is a very perfect whole, and has been made, in a most able memoir of M. Elie de Beaumont, a stronghold of the theory of "elevation craters" of which Mr Scrope expresses his most unqualified disapproval.

The Cantal is an almost regular cone of 30 miles in diameter, rising at the highest point, called the Plomb du Cantal, to 6096 feet. As its basis is already tolerably elevated, the average slope is very moderate, and in most parts it is singularly uniform, composed of grassy declivities admirably adapted for pasture, and only slightly furrowed by water-courses of trifling magnitude, which, as they are almost all radially directed along the slopes, tend to every point of the compass. The "Plomb," however, although the highest point, is not the exact centre either geographically or geologically. That is more correctly found at the Puy Griou, which, according to M. Elie de Beaumont, is the dynamic origin of the whole group. This was, according to him, an eruptive protrusion of clinkstone posterior to the deposition of the vast basaltic plateau, or rather mantle, which now constitutes the shell of the whole mountain of the Cantal, which, in conformity with the views of Von Buch, he supposes to have spread itself out comparatively on a level, and to have been afterwards elevated by the expansive throes of the ascending clinkstone into its present conical form. However much the opponents of the theory may be inclined to reject this view, it cannot be denied, —indeed, Mr Scrope, in his disclaimer, does not deny—that the expansive force of earthquakes have rent the volcanic crust, and in rending it, have added to its elevation. The very remarkable transversal fissure from Aurillac to Murat, through which the public road at present crosses diametrically the whole mountain, can scarcely be considered as otherwise than a crack, the result of upheaval; and it seems not unreasonable to believe that the appearance of the clinkstone of the Puy Griou, which centrically divides the fissure, was intimately connected with its formation. The climate of the Cantal is probably unfavourable for geological researches. At least, the writer of this notice has been twice driven from the poor shelter of its inns by incessant rain.

Near Murat, the tourist admires colonnade above colonnade of basaltic formations rarely paralleled in beauty. At Chaudesaigues, on the southern outskirts of the Cantal, there rises from the granitic substratum the hottest spring in Europe out of Iceland.

IV. Le Puy *en Velay*, as it was formerly called, now the capital of the department of the Haute-Loire, is one of the most curiously situated towns in France, and if second in amenity to Clermont, its environs are scarcely inferior in geological interest. The Loire takes its origin in a remarkable basin surrounded by a nearly circular rampart of mountains, of which the town of Le Puy occupies the centre. The mountain rampart, though it rises in some places to a considerable elevation (the Mont Mesenc on the south-east being its culminating point, 5820 feet above the sea), does not, at a distance, present many striking outlines. The whole has probably been swept over by repeated diluvial currents, which have abraded and modified the configuration of the ground. The River Loire escapes from the ring of hills by a narrow gorge undistinguishable at a distance; and the closure of this gorge, which would convert the whole into a lake, would afford an explanation of the tertiary deposits intermixed with the volcanic formations near the town, by a far easier supposition than any which will account for the correlative strata which form the "Limagne" near Clermont.

Le Puy is situated nearly 70 miles south-east of Clermont, and about 40 miles to the east of St Flour, a town at the eastern foot of the Cantal. Whoever, like the present writer, has walked over this last route, will remember it as one of the dreariest and wildest of his topographical recollections. The upper valley of the Allier, which is crossed in the course of it, must, however, be excepted; offering some pleasing sites, and also some interesting volcanic sections. It was here that our modest and indefatigable countryman, Dr Hibbert, discovered the bones of mammalia overlaid by streams of lava; a discovery since made elsewhere in these countries, but Mr Scrope, we think, does not name Dr Hibbert as the originator of it. One of these interesting specimens is now in the collection of the Royal Society of Edinburgh. Leaving the Allier, we tread basaltic plateaux of a sterile and monotonous character, until, after many a weary step, the eye of the traveller brightens as he gets sight of the well-watered hollow of Le Puy, with its cultivated slopes and vine-clad terraces, the straggling old town encircling the steeps of the Mont Anis,* where stands an interesting and ancient cathedral church, while farther off rises the volcanic *aiguille*, on whose seemingly inaccessible summit is perched the chapel of St Michael, that winged saint whose shrines are usually found in such aërial situations as at Mount's Bay in Cornwall, and on the coast of Normandy. An excellent view of the Mont St Michel at Le Puy may be found in the old work of Faujas St Fond.

The singular and diversified panorama which may be viewed from any of the higher elevations near Le Puy, as, for instance, the Montagne de l'Ours, is thus graphically described by Mr Scrope in his explanation of Plate XI. of his work :—

"The view from this point is exceedingly instructive, embracing all the features of an interesting and singular country. The Mont d'Ours is a double volcanic cone of recent formation, although its craters have disappeared. The eruptions by which it was produced burst through a vast bed of volcanic breccia and basalt, which is still visible in the village of Ours, and forms a succession of rocky terraces from thence towards Le Puy. It rises near the eastern limit of the fresh-water formation, the remains of which are seen on every side resting against the primitive margin of the cavity in which it was deposited. To the south-east are seen the highest summits of the Mezen, and from thence to the north the horizon is bounded by a chain of rocky eminences, the ruins of an enormous current of clinkstone which that volcano has poured forth towards the north. * * * * The basaltic currents of the Mezen, which, accompanied by prodigious alluvial accumulations of brecciform conglomerate, overwhelmed the whole surface of the fresh-water formation, are observable in all directions; and it is evident, from their being found on both sides of the Loire, that this river's actual bed was not yet formed at the era of their descent. The channel by which the Loire now issues from the basin of Le Puy may be observed to have been pierced entirely through granite, although at the very edge of the calcareous formation; a remarkable fact, seeming to show that even the softest marls, under a protecting cover of basalt, resist meteoric erosion far more effectually than granite itself.

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* The ancient name of Le Puy was *Anicium*. Bertrand, "Descr. du Puy."

"It was by the excavation of this narrow, deep, and tortuous gorge that the waters dammed back in the basin of Le Puy could only be discharged. As the channel gradually deepened, the valleys that now intersect its tertiary and volcanic formations were progressively formed. That this was effected by degrees, and not by any sudden debacle, is proved,—1st, by the undisturbed state of the cones of scoriæ; 2d, by the great variety of levels at which the lava-beds occur. They appear, in fact, as in the valley of the Limagne, to be more recent the lower the level they occupy; thus marking the successive steps of the process of excavation. It is, however, possible, that some cleft, broken through the granitic barrier by subterranean expansion, may have assisted the discharge of the lake in that particular direction.

"The prospect to the west is equally interesting. The horizon on that side is limited by the vast chain of volcanic cones which, commencing at the foot of the primitive heights of La Chaise-Dieu, reaches uninterruptedly to Pradelles. The lower streams produced by these eruptions have deluged an extensive and nearly level plain, stretching from the foot of the range to Le Puy. This is intersected by the channels of various torrents, and may be seen to consist of repeated currents of basalt resting on the fresh-water limestone. A few insulated cones are scattered over the plain, and some occur at a considerable distance from the line upon which the greater number of eruptions have broken forth.

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"The valley of the River Borne, from which rises the town of Le Puy, the capital of the department Haute-Loire, is not the least interesting part of the view. Its numerous feeders, which unite near the remarkable insulated and regular columnar rock called 'The Organ of Expailly,' have each their channel cut through a system of basaltic beds, generally columniform, often double, with a bed of conglomerate or alluvial matter interposed, and resting on the fresh-water limestone strata. The great mass of volcanic breccia, called the Rocher Corneille, is seen rising above Le Puy, as well as the spiry pinnacle of St Michel, formed of the same substance, and standing up in the middle of the town. A similar mass rises from the town of Polignac, as seen above, at a distance of about four miles. These rocks were favourable sites, of course, for chateaux forts in the *good old* times of rapine and butchery; and most of the towns of the central provinces of France were built under the protection of some such fortress. There are perhaps few spots on the globe which offer a more extraordinary prospect than this. To the eye of a geologist, it is superlatively interesting, exhibiting in one view a vast theatre of volcanic formation, containing igneous products of various nature belonging to different epochs, and exhibited under a great diversity of aspect." (Scrope, p. 24.)

The following extract, relating to the occurrence of *human bones* amongst those of the elephant and rhinoceros, beneath the more recent basaltic lavas, is the most interesting among the additions to the present edition. It would be desirable to obtain, if possible, even farther guarantees for the perfect accuracy of so remarkable a narrative:—

"The cone that has attracted the most observation, owing to its immediate vicinity to the town of Le Puy, is that of the Montaigne de Denise. And it does, in fact, offer some peculiar features of an interesting and problematical character. The summit and flanks of this oblong hill are covered with large accumulations of very fresh-looking scoriæ, lapilli, and puzzolana, out of which several prominent masses of basalt are projected into the valleys around and beneath. * * * Other massive rocks of a breccia or peperino similar to that of the Rocher Corneille in the town of Le Puy, constitute the nucleus of the hill itself; and through these the eruption of the more recent lava and scoriæ evidently broke out. This massive and indurated peperino is of much earlier formation than that which accompanies the erupted lavas and scoriæ, although the two breccias can with difficulty be distinguished, and in places appear almost to graduate with each other. There would be little remarkable in this, were it not that in the last-mentioned stratified deposits large quantities of bones are found of elephant, rhinoceros, *Cervus Elephas*, and other large mammifers, and in one locality the undoubted remains of at least two human skeletons. A block of this breccia, containing the greater portion of a human skull and several other bones, is preserved in the museum of Le Puy. The matrix in which these fragments are firmly embedded is unquestionably a portion of a stratum of indurated tuff or breccia, which envelopes and passes into the basaltic lava of Denise. The examination I made on the spot, which is just above a house called The Hermitage, on the road from Le Puy to Brioude, left no possible doubt of this fact on my mind. It was discovered in 1844, and the attendant circumstances were carefully attended to, and reported to the Academical Society of Le Puy by M. Aymard. At the meeting of the Scientific Congress of France which took place at Le Puy in 1856, the question of the genuineness of this specimen was discussed, but no reasonable doubts could be thrown upon it, and the great majority of *savans* who examined the question were of that opinion. Nor, in truth, need there be any surprise at the discovery that this district was inhabited by man at the period when the most recent volcanoes were in eruption. The more remarkable inference from the discovery of these bones is, that man had for his contemporaries in this country several races of extinct mammalia of the genera rhinoceros, elephant, &c., whose remains are found in the similar stratified breccias occupying the same position on the slopes of the same volcanic cone. It is also evident that vast changes must have taken place in the configuration of the country since the eruption of the volcanic vent of Denise," and consequently since its occupation by man. The valley of the Borne must have been greatly widened and deepened, if not entirely excavated, since that epoch, and the time required for these changes throws back the date of the eruptions—which buried in its ejections the two human skeletons of Denise—to a very distant period.—(*Scrope*, pp. 181–3.)

Geological visitors to the district of Le Puy have for many years been indebted to the knowledge and the hospitality of M. Bertrand de Doue, to whose name hardly sufficient prominence is given by Mr Scrope. He published in 1823 an excellent lithological description of this (then) little known country, illustrated by a useful map, not yet, we believe, superseded, which, indeed, forms a necessary appendage to those of Mr Scrope. Those who have ever profited by the information and kindness which M. Bertrand has afforded to more than one generation of tourists, will understand why the writer of these lines, who has done so on more than one occasion, feels a pleasure in placing it on record.

V. The Vivarais or Ardêche.* The mountainous range which divides the sources of the Loire, which falls into the Atlantic from the tributaries of the Rhone, separates also the volcanic tract which we have just considered from the fifth and last on our list, which has characters of its own distinct from the others, and which has, from its remoteness, attracted fewer tourists than any of the others, with the exception, possibly, of the Cantal.

The mountains in question, which form part of the range of the Cevennes, culminated at the Mont Mezenc, as already mentioned. They belong to the ancient province of the Haut-Vivarais, and separate the Velay and Haut-Vivarais (or Haute-Loire) on the north, from the Bas-Vivarais or Ardêche on the south. These mountains, mostly trachytic, and on whose somewhat obscure geology we have not space to enlarge, are wild and sterile, presenting views often singular, but rarely pleasing. The climate is most ungenial for the latitude of 45°. The thinly scattered population is of a rude and almost lawless character. The traveller is instinctively thrown upon his guard by the demeanour of the peasantry, their surly independence, harsh language, and especially by the suspicious curiosity with which his motions are regarded. Further inquiry does not belie appearances. Drunkenness and savage crimes are but too common. An astonishing and seemingly incredible instance happened not many years since, at a lonely inn on the public road between Aubenas and Langogne. A party of several persons, travelling in their own carriage, had stopped to spend the night. It was subsequently discovered that they had been barbarously murdered, their carriage burnt, and the horses killed! The innkeeper and his wife being convicted of the crime, afterwards suffered capital punishment on the spot where it had been committed.

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* In speaking of this division, Mr Scrope has, by an oversight, omitted to mention the valuable paper by Professor J. D. Forbes on the volcanic geology of the Vivarais (Ardêche), which was published in the twentieth volume of the Transactions of the Royal Society of Edinburgh, and which contains a full account of this interesting volcanic district, with map, plans, and sketches.—EDIT. Edin. Phil. Journal.

Descending from these thinly peopled heights, the traveller's eye is gladdened by the prospect of valleys of a cheerful and luxuriant character. "It would be perhaps difficult," says Mr Scrope, "to find in any range of mountains scenes which present a more exquisite combination of beauty and magnificence than some of the valleys of the Bas-Vivarais, so little visited by hunters of the picturesque. The rich glow of their chestnut forests, tinted by a soft and brilliant atmosphere, is far more adapted to painting than the cold transparent colouring of the Alps and Pyrenees, their pine forests and waterfalls; nor can the outline of their masses be considered as much inferior in grandeur. [This we hesitate to admit.] The scenery is in fact that of the Apennines, but with a more luxuriant vegetation than that great *limestone* range can support." One of Mr Scrope's most striking views, that of the village and valley of Jaujac, as coloured in his earlier edition, is a fit commentary on these remarks.

The various tributaries of the River Ardéche (which gives its name to the modern department) water these charming valleys, which, without being densely, are reasonably well peopled. The villages are tolerably numerous, and highly picturesque. The chief industry is the silk culture. Magnificent forests of chestnut, set off by their deep green mantle the picturesque forms of the red volcanic cones which here and there rise from above their foliage. But the most singular, and in some respects the most picturesque, feature of the scenery remains to be mentioned. Every valley, without exception (within the limits of the districts we are describing), contains a flow of basaltic lava, which seems to dispute with the stream of pellucid water the occupancy of the *thalweg* or trough of the ravine. The water, however, proves itself no contemptible antagonist to the massive beds of blue-grey stone which in order of time first made good their possession of these glens. *Gutta cavat lapidem* was never more pregnantly illustrated; and the result is, in several instances basaltic colonnades of stupendous magnitude, and almost unequalled regularity of geometrical figure, at the foot of which the torrent flows, and over which, by a slow but sure process of undermining, it gradually obtains the advantage. These lava streams may in every instance be traced to their origin in the volcanic cones before mentioned, which have a striking analogy, geologically speaking, with those of Clermont, though, owing to their accompaniments, they are infinitely more picturesque. Like those, they rise from gneiss; and in a majority of instances seem to have expended their entire energies in giving birth to a single lava stream, since the date of which they have been perfectly quiescent.

The chief points of the volcanic geology of the Bas-Vivarais were tolerably well described, exactly eighty years ago, by Faujas de St Fond, according to the extent of his information and the science of that time. Mr Scrope's work had the great merit of recalling attention to this district, although, even since its publication, but a very small number either of travellers or geologists have been tempted to explore its charming recesses. We may here add, for their information, that (unless a great improvement has taken place of late years), the only tolerable quarters would be found at the little watering-place of Vals. But those whe prefer beauty to comfort will find themselves more favourably situated in the romantic village of Thuetz, at the foot of the volcano of Mouleyres.

In conclusion of the whole subject, we quote the following general remarks of Mr Scrope on the volcanic formations of central France:—

"Although the evidence of their more or less degraded appearance and position proves the volcanic rocks of central France to have been erupted at many distant periods, and not at any one, two, or three epochs alone, yet there is reason to suppose some of these eruptive periods, more or less prolonged, to have been of extreme or paroxysmal energy. This, indeed, would only be in accordance with the habitual laws of volcanic action. To the earliest of such periods we may ascribe the production of the three chief volcanic mountains—the Mont Dore, Cantal, and Mezen. This outburst seems to have commenced towards the close of the deposition of the Miocene lacustrine strata. Several, likewise, of the independent basaltic beds that cap the highest hills of that formation, as well as those of calcareous peperino, in the middle of the basin, belong evidently to a date quite as early. The larger proportion of the chain of Puys, of the Monts Dôme, and Haute Loire, especially the latter, must be attributed to another and comparatively recent eruptive era, which, from the evidence of organic remains found in the underlying alluvia, is referable to the Pliocene age. In the long interval between these two periods very many eruptions certainly took place from openings on the flanks of the volcanic mountains, as well as along the eastern face of the Limagne and Forèz—eruptions whose lavas are found at varying heights above the existing river courses, and which, therefore, cannot be referred to any single epoch. And again, the most recent lavas and cones of the Monts Dôme and the Bas-Vivarais have evidently broken forth at a yet later period—the Post-Pliocene;—probably even since the appearance of man in the country—although several species of the larger mammifers, now extinct, were contemporaneously it inhabitants." (Scrope, p. 209.)

Teneriffe, an Astronomer's Experiment; or, Specialties of a Residence above the Clouds. By C. Piazzi Smyth, F.R.S.S. L. and E., &c., &c., Her Majesty's Astronomer for Scotland.

In early youth, the dullest of mortals drinks in greedy draughts of pleasure from imaginary pictures of foreign lands. Who has not heard the roar of Niagara? Who has not caught the tinkling sound of the sheep-bell on the hill-sides of Palestine? Who has not watched the fishermen as they dragged their nets to the shores of the Lake of Genesaret? Who has not ventured a trembling peep into the crater of Etna, or pitched a sod into the boiling Geyser? So vivid are these day-dreams of our boyhood, that they often eclipse our real experiences, and weave for us a fancy web of our own imaginings, from which we cannot free ourselves. To what ear does not the mention of the Peak of Teneriffe develope a dormant mental photograph of a lofty mountain, whose summit pierces the clouds, and whose base is washed by the ocean?

Our readers will observe that we are indulging in a spice of sentimentalism; but they will pardon us when they learn, that in doing so, we are bidding such things farewell for ever. The rich old pictures from "Clarke's Hundred Wonders," which used to come trooping up from the storehouse of memory on all occasions to aid our dull imaginings, are being gradually blotted out. Scylla and Charybdis vanished, we don't know how long ago. The Maelstrom has received its quietus from the magic touch of Lord Dufferin. Mont Blanc, even, has lost its supremacy, since it has been done by English tourists without a guide. But Teneriffe—the ocean sugar-loaf—still remained, until these vile photo-stereographs, with which the work before us is illustrated, revealed the unpalatable truth that the modern Peak is no more like the Peak of our boyhood than Mantua is like Rome.

Spite of the humiliating disclosure of this tell-tale photography, the book is very interesting; and having read it from end to end, we venture to anticipate that the report we have to make of its contents will induce others to follow our example. If we did not find our old imaginary picture of the Peak, we found in its place many fresh and striking pictures, both of men and of scenery.

The origin of the book is as follows:—Newton concludes the first part of Book I. of his *Optics* in these words,—"Telescopes cannot be so formed as to take away the confusion of the rays which arises from the tremor of the atmosphere. The only remedy is a most serene and quiet air, such as may perhaps be found on the tops of the highest mountains above the grosser clouds." Impressed with these remarks, or at least with the ideas which they convey, Prof. Smyth, who suffers perhaps more than most astronomers from the position of his Observatory, had for some years been urging on the Government the propriety of allowing him to transport certain of the instruments, during the summer months, to the top of some hill. In his report to the Board of Visitors, Nov. 1852, he proposed the Peak of Teneriffe, of all high mountains the most quickly accessible from England, and the most easily climbed. By dint of exertion, he at length induced the Lords of the Admiralty to place at his disposal the sum of £500 for defraying the necessary expenses. Mr Stephenson, the eminent engineer, kindly offered him the use of his yacht *Titania*, of which he availed himself; and in the month of June 1856, set sail for the island of Teneriffe, from which he returned in the autumn, deeply laden with scientific facts and unscientific experiences. These he busied himself in throwing together in a readable form; and we believe he presented the whole to the Government, in whose service they had been accumulated. The Government selected the scientific portion, and placed it in the hands of the Royal Society of London for publication. The popular portion they left to the Professor's own disposal, probably from a due consideration of the value of the work as literary property, to which they had no claim. However that may be, Professor Smyth was so fortunate as to be the proprietor of his interesting story, and he has presented it to the public in the volume before us, illustrated by twenty photo-stereographs, taken at various points in the island.

But it is time that we turn to the work itself. We are disposed to find fault with the title-page,—"An Astronomer's Experiment." The last word, "experiment," summons up grim and dark ideas. It recals a picture of that excellent astronomer, Dr Lee, in the transit-room of Hartwell House—the scene faintly illuminated by a lantern suggestive of thieves and policemen—the Doctor himself sitting in solitary dignity between a clock and a telescope—three of his senses occupied simultaneously in seeing, hearing, and recording the important fact, that a certain star crossed his meridian at 3 hours, 5m., 2·7s. mean solar time. A very interesting fact, no doubt, to the Doctor himself. But who cares whether the worthy man was asleep or awake at that hour? Nobody does. Professor Smyth will therefore allow us to correct his title-page to "An Astronomer's Experiences." And very lively experiences they were. The book opens with the following passage:—"Once within the parallels of the trade-wind, every other natural phenomenon is found to give way before that grand commotion of the atmosphere." And the hurrying of the clouds above, and of the waves beneath, seems to have communicated its influence to the author's pen; for he dashes on, presenting his readers with a slightly sketched but enjoyable panorama. We envy those who are enabled to make a yacht voyage. They can peep into nooks and crannies of the earth which ordinary travellers have no chance of reaching. But it seems there is some drawback to the pleasure. Professor Smyth exclaims,—"How she did roll! in manner not disagreeably—for a delicate digestion was not disturbed." We have heard something about this same delicate digestion (what a delicate phrase!), and are disposed to attribute its want of disturbance to the judicious use of stimulants. The stewards recommend champagne, which is not to be thought of—essence of ginger is better and cheaper, to say nothing of the temperance question. The rolling of the *Titania* had one good effect. It afforded the Professor a fair test of the applicability of his apparatus for making astronomical observations when the ship was in motion. The Council of the Royal Astronomical Society, in their annual Report just issued, express their opinion that, "so far as the simple free revolver and the artificial horizon are concerned, the principle was most successfully put to trial in practice in the voyage to Teneriffe."

The party, consisting of Professor Smyth and his wife, with a couple of sailors, land at Santa Cruz. The description of the place, and its inhabitants, brief as it is, convinces us that its author sees with the eyes of an artist. Take this specimen:—

"When walking at mid-day in one of the basalt-paved streets, each glittering stone sending back the full rays of a vertical sun, and the gleaming houses on either side affording a steady white-hot glare of unmitigated sunshine—what words in a northern language can express the delightful emotions, when, at the open gateway of one of the semi-Moorish abodes, we look in upon a grove of bananas! Throwing a tender green shade over the interior court, their grand and delicately structured leaves rise up aloft, catch the fierce rays of the sun before they can do mischief, receive them into their substance, make them give out the most varied yellow greens; pass them on from leaf to leaf, subdued and softened; pass them on to the oleanders fountain of rose-pink flowers, to the dark green of the orange, the myrtle, and the bay; and leave just light enough at last in the green cavern below, to show the bubbling of some tiny fountain, the welling heart of this fairy oasis. Our fashionables, who visit Italy and Spain in winter only, how little do they know of the province of the sun!"

From Santa Cruz they cross the island to Orotava. Hence they ascend Guajara, a mountain 9000 feet high, four miles to the south of the Peak. The ascent of this mountain, which occupies a long day, brings them to their first observing station. Here they remain five weeks. For their varied experiences in this elevated region the reader must consult the work itself. We have space only to give one extract as an example of the author's playful style:—

"While engaged with the sailors in unscrewing the telescope boxes, I looked up, and lo! a little bird of the fringilla species—a very little bird as compared with any that a working man would generally care for—came and perched on a stick that had been fixed in the ground close by, to show the site of an intended angle of the wall. A tame, innocent bird it was, not unlike a common linnet; it hopped about as far as the confined area of the stick top would permit, now to the right, now to the left; then, stooping down, wiped both sides of its bill cleverly on the edge of the wood; looked up at us archly and merrily again; and once more began hopping backwards and forwards as at first, in azimuth, if I may be allowed so to say. In fact, it performed its part so prettily, that with my head full of expected canaries on this the highest island of the Canary group, I asked our interpreter by what name he called this exemplary little bird of the brown plumage. He looked at it, and started, quite sportsman-struck, as if he had seen a stately antelope. Without answering my question, he called Manuel's attention to the diminutive fowl, not five feet off, and he looked also; then they both had a long and animated discussion, at the conclusion of which the interpreter turned round and assured me, with infinite *empressement*, that 'the bird was remarkably good eating; and that if he had only his musket with him, he would shoot the creature then and there.'"

Having completed their observations at Guajara, they remove to the Peak itself, and station themselves on *Alta Vista*, 10,700 feet above the level of the sea. Hitherto, no attempt had been made to bring up the largest instrument. Nor did it appear very easy to transport it to the mountain, owing to the weight of the packages in which it was distributed. Now, however, the Professor resolves on making the attempt. Descending to Orotava, he has the good fortune to fall in with a German watchmaker, by whose skill he is enabled to break the instrument into smaller pieces, and, having done this, finally to convey it on the backs of mules to his lofty observatory.

It is to be regretted that the season was now pretty far advanced, so that only a few of the various phenomena which so clear an atmosphere might have revealed could be noted ere the storms of autumn compelled the astronomer to beat a retreat. The following extract will show what is the state of things in that region:—

"The usual mere streaky bands which cross the disc [of Jupiter] became resolved in the telescope, under high powers, into regions of cloud. The brighter spaces were the clouds, and their forms were as characteristically marked, and were drifting along as evidently, under the influence of a rotation wind, as the cumuli and cumulostrati which the terrestrial N.E. current was at that moment bringing past Teneriffe, before our eyes and under our feet. On each of three nights that I made drawings at the telescope of these Jovian clouds, the effect of the planet's rotation was abundantly evident; while, in addition to this, there were minute changes in the relative positions and forms of the vaporous masses in either hemisphere that indicated as well the presence of winds as the ephemeral nature of mist.

"Far more striking, however, was the testimony borne by the more constant forms of the cloud, seen best toward the equatorial part of the planet. At this tract, one could not gaze long without acquiring the impression of looking at a windy sky; the whole zone of vapour seemed to be in motion, while, from its ragged edge, portions were torn off, and were driving along, some of them rolling over and over, and others pulled out in length and rearing up towards the fore part, like a sailing boat scudding before a gale."

The concluding chapters are devoted to the Lowlands of Teneriffe. Perhaps these chapters will, by many persons, be regarded as some of the most interesting and instructive in the book. We dare not extract largely from them, but our readers will certainly thank us for giving them the author's remarks called forth by a ramble in the cactus gardens. These gardens are cultivated for the sole purpose of the growth of the cochineal insect, now the chief support and mainstay of the island:—

"The circumstances of the introduction of this new industrial resource bear quite a providential aspect. Who would have thought in 1835 that the years of the grape vines of Teneriffe were numbered? Had it not been a vine-producing country for 300 years, and what was to prevent it going on for ever? said naturalists of non-secular progress. So, when a native gentleman introduced the insect and its appropriate cactus from Honduras in that year, his friends thought him a simpleton; and the country people destroyed his plantations at night, because they were an innovation not to be tolerated in a land of grapes.

"The Government, however, happily supported the spirited improver; and, though at the expense of an agrarian disturbance now and then, some cochineal and cactus were preserved in the out-of-the-way parts of the island.

"Time passed, and the vine disease fell on the land. The fruit withered, the plants died, starvation stared every one in the face. Orotava, so frequently visited before by Americans anxious to exchange deals and timber for wine, was soon entirely deserted by that calculating people. Then came the experiment, cochineal-growing in the abandoned vineyards. It succeeded to admiration. The insect propagates rapidly, and its embryos spread from hand to hand. A *furor* in its favour soon took the people, and has not yet subsided. Spare land, gardens, and fields were all turned into cactus plantations. Within six months after setting out the leaves, harvesting may begin. Such a profitable investment of the land was never made before. An acre of the driest ground planted with cactus was found, we were told, to yield 3 kintel, that is 300 lb. of cochineal; under favourable circumstances, 500 lb.—worth £75 to the owner."

Thus, the loss of the vine has turned out, to the south of the island especially, a real gain, by the wise working of that Power which "from seeming evil still educes good." With this important lesson we close our extracts from a work rich in novelties. The illustrations are in themselves a characteristic feature of no mean value. Either from the language which they address to the eye, or from that which the author addresses to the ear, we are left in a delightful state of confusion as to whether we ourselves have not been in Teneriffe—have not sat on Guajara, where cloud-land formed our lower world. We have learnt, at any rate, from this "experiment above the clouds," to comprehend the words of the sacred poet when he says, speaking of the majesty of Jehovah,—"The clouds are the dust of His feet."

Memoirs of Hugh E. Strickland, M.A., Deputy Reader of Geology in the University of Oxford. By Sir WILLIAM JARDINE, Bart. *With a Selection from his Printed and other Papers.* London: Van Voorst.

The difficulty of rendering biography impartial is considerably increased, when the bond of union between the author and the subject of his memoir is a nearer tie than even that of friendship proceeding from a similarity of tastes and pursuits; but to this difficulty Sir William Jardine is not insensible, and that it is not insurmountable, we have evidence in the judicious volume lately brought before the scientific public, entitled "Memoirs and Papers of H. E. Strickland."

The memorial of Strickland's private character is a tribute to his memory offered to his family and friends, and there is little that even the general reader would wish omitted; while the collection and reprint of his scientific writings will alone command a place for this work in the library of every student of natural history.

Hugh Edwin Strickland was born in 1811 at Righton, in Yorkshire, and was the son of Henry Eustatius Strickland, a younger son of the late Sir George Strickland, Bart., of Boynton, and Mary, the daughter of Edmund Cartwright, D.D., F.R.S. His childhood appears to have been an earnest of his after life, for the most decided trait in Strickland's character as a man was the "distaste for all exaggeration," and "the minute attention to details," which Sir William records as a characteristic of his early boyhood. At Oxford he attended the lectures of Dr Buckland; but it is evident that he had already formed opinions on the great science of geology, which were afterwards to be matured and modified by much attentive study.

Notes were taken, from his boyhood, on all kinds of subjects, "of things seen and to be seen, of books read and to be read;" memoranda on "geology and zoology, statistics and antiquities, mechanics and literature;" and he left Oxford strongly imbued with that love of science, which was afterwards to be developed in the wise and thoughtful man. Soon after he left the university we find him busily engaged on the geology of the Great Severn Valley, assisting Mr Greenough in the construction of his geological map, and a coadjutor of Edwin Lees, the botanist, in colouring geologically a map of Worcestershire for the Natural History Society of Worcester. "A most remarkable production, considering that the 'Silurian System' had not appeared, and that most geologists were all abroad 'On the Geology of the Malvern and Abberley range.'"*

The important discovery of marine shells, by Mr Jabez Allies, in the gravel of Kempsey and other localities of the old Severn Straits, was communicated by Strickland to Mr Murchison (now Sir Roderick); and to no one, save the Rev. T. T. Lewis of Bristow, and the late Dr Lloyd of Ludlow, does Sir Roderick Murchison owe more acknowledgment of assistance in the preparation of his famous work, "The Silurian System."

An interesting account of a tour to Auvergne and to Asia Minor is given from Strickland's own journal, illustrated by plates from his sketches. Mr Hamilton, lately the President of the Geological Society, was his companion, and this tour led to several important geological and ornithological papers. Respecting the migration of birds, some interesting facts are recorded. "The song thrush is a winter visitant to the vicinity of Smyrna, and with it some of the birds only seen in Britain during the winter, such as *Turdus pilaris* and *iliacus*, and *Fringilla montifringilla*. The plate of "*Emberiza cinerea*" (Strickland), a beautiful bunting discovered near Smyrna, is one of the most life-like specimens of lithographic art we have ever seen.

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* Trans. Malvern Field Club. President's Address, 1855.

On his return to England, Strickland's attention was directed to "Home Geology," and we find him in almost constant correspondence with Sir R. Murchison, and re-editing the "Geology of Cheltenham," in conjunction with Professor Buckman; while the working naturalists of his own neighbourhood found in him a ready friend when they required assistance and information. His papers on local geological phenomena, printed in the second part of the volume, are very important.

The interesting inquiry into the "Vitality of Seeds," the "Reform of the Nomenclature of Zoology," "Fossil Entomology," and the "Nomenclature of Colours," were subjects to which he devoted much attention; and we find him also greatly interested in the surveying expedition of H.M.S. Beacon, as is expressed in a letter to his friend, the distinguished Edward Forbes, who then expected to travel over much of his former route in Asia Minor.

In 1843, the editing of the "Bibliographia Zoologiæ," Agassiz, for the Ray Society, occupied much of his time; and it is evident that Dr Johnston of Berwick, Sir William Jardine, and Strickland, may be considered the founders of the "Ray Club," the original conception of which was "sketched at Cork by Strickland."

On the publication of the "Elements of Physio-philosophy," by Lorenz Oken, the Ray Society fell somewhat into disrepute, and Strickland's letter to Professor Bell is very characteristic. "It would undoubtedly have been more prudent in the Council not to have published it"—"but though I regret that the Ray Society published the work, yet I am glad, in the abstract, that an English translation of Oken has been published. Unquestionably the greater part is nonsense; but the work is interesting, first psychologically, to observe the kind of nonsense which a powerful mind produces when it attempts to grapple with subjects which are beyond the reach of the human faculties, and when it deserts the Baconian or inductive mode of reasoning. It is a kind of nonsense very different from the trash which inferior minds produce abundantly in these days. In one of the early volumes of the Ray Society, he translated and superintended the publication of the Report on the state of Zoology in Europe by Prince Lucien Bonaparte.

On the 23d of July 1845, Hugh Strickland was married to Catherine, second daughter of Sir William Jardine, Bart. To this lady's pencil we owe most of the beautiful plates which enrich the volume before us.

In 1846, we find him engaged on the "Ornithological Synonyms," one volume of which is published and edited by Mrs Hugh Strickland and Sir William Jardine, and in which, we are informed, "520 separate works are quoted from;" at the same time, he had on hand the "History of the Dodo," in conjunction with Dr Melville, and the editing of the "Bibliographia," for the Ray Society. This tremendous work told, however, on his constitution, and it was a general remark that Strickland was becoming "prematurely old." In 1850, he was appointed successor to Dr Buckland in the Geological Chair at Oxford, when he became justly popular with the students of natural history, though both Buckland and Strickland would have been more justly appreciated at New York, or at Edinburgh, than in Oxford; yet "Oxford was his darling," and "no opportunity was let slip to improve, or reform, or exalt her among universities."

The manner of Strickland's death is well known; he was run over by a railway train, while engaged in examining a section on the Manchester, Sheffield, and Lincolnshire Railway, near Retford, after the meeting of the British Association at Hull. Two trains happened to be passing each other, and his attention being fixed on an advancing coal-train, a passenger train rushed on him unseen and unheard. "Death must have been instantaneous; there could be no pain, not even a momentary feeling of alarm and fear." "It would be contrary to the objects of this memoir," says Sir William Jardine, "to write of his private virtues, or enter upon the griefs and sorrows of near relations and friends;" still, few men had more friends or have been more beloved than Hugh Strickland. The memorial windows of Deerhurst and Watermoor churches were not erected to the memory of the geologist and ornithologist, but to the FRIEND who was ever ready to hold out the hand of kindness to those who engaged in similar pursuits, who was never puffed up with the idea of his own consequence, or affected the impertinence of hauteur to those who were beneath him in position or repute. Hugh Strickland had a RIGHT KINDLY HEART, and the members of the three Natural History Field Clubs, who erected those stained-glass windows to his memory, thought as much of the MAN as of the PHILOSOPHER, in these testimonies of their regard and esteem. Think well of this, ye dyspeptic philosophers, who cultivate the head, but not the heart. Hugh Strickland combined gentleness with wisdom, and simplicity with knowledge and moral worth, or there had been no memorial windows in the old grey church at Deerhurst, or the more modern structure at Watermoor!

Not that we would for one moment detract from his claim to rank among the foremost of our British naturalists. As a geologist, we have no hesitation in declaring, that he was one of the soundest, most really philosophical of those who have any claim to the title; and as an ornithologist, we remember that Prince Charles Lucien Bonaparte thus addressed a parcel of bird's skins to him at Oxford, "To H. E. Strickland, Esq., the great English Ornithologist;" and Prince Bonaparte's is no mean opinion. It is not possible to read the list of his collected writings without perceiving that "his acquirements in literature and general science were of a very high class;" and the lovers of literature and science owe their best thanks to Sir William Jardine, for collecting and preserving the fruits of so much labour and perseverance, which, no doubt would have assumed a more connected form had the days of their lamented author been "longer in the land."

Address to the Meteorological Society of Scotland. By JAMES STARK, M.D., F.R.S.E. Read before the General Meeting of the Society, 18th January 1858. J. Menzies, Edinburgh.

Observations in Meteorology, being chiefly the results of a Meteorological Journal, kept for 19 *years at Swaffam-Bulbeck in Cambridgeshire.* By the Rev. LEONARD JENYNS, M.A., F.L.S., &c. 8vo. 1858. London: Van Voorst.

Information taken from the Log-Books of Herring Vessels. Published by the Royal Meteorological Institution of the Netherlands. Translated by the Board of Trade. 8vo. 1858. London: Eyre and Spottiswoode.

Scotland has a Meteorological Society, but how long that may be is another question. At the meeting of the British Association in Glasgow in 1855, a resolution was passed by the general council, strongly encouraging meteorology in Scotland, and a few gentlemen formed themselves into an association for the purpose of organizing a regular system of observation. By them a prospectus was issued for the institution of a Meteorological Society; about 200 members enrolled themselves and guaranteed a subscription for three years; and the Address, of which the title is given at the head of this article, is a summary of the transactions of the Society for the bygone year, drawn up by its Secretary for the use of members.

Meteorology had long been viewed in Scotland with much interest; her variable seasons bearing so much on personal comfort and health,—of so much importance to the husbandman or gardener,—to the sailor or sea fisherman, gave it an irresistible interest; and observations and registers were kept by numerous parties of almost all ranks and conditions, sometimes only as a private recreation, but at times with the higher attempt of obtaining an insight into the average climate of the district. But these observations, however carefully registered, sometimes for a lengthened period, could not be used for any general purpose. Comparison of instruments, elevation above the sea-level, time of registration, and many other points had not been worked upon a regular system; and the results consequently could not be placed in comparison, or any facts based upon them; hence, combination among the observers became essential, and no better plan could be devised than the establishment of a society such as that instituted at the Glasgow meeting of 1855. By this time also, the utility and importance of meteorology was publicly recognised in America and on the continent of Europe. The observations made in the former country in relation to the winds and storms ranked as the most important modern results in this department; and in these countries government lent its aid from the public purse. The sanatory condition of a country is materially regulated by atmospheric changes; and what is the utility of a public board of health, with an expensive staff, if the affecting causes are not attended to? The interests of agriculture are intimately connected with the changes of the weather, and the mysterious appearance and progress of diseases which have attacked vegetable products, both at home and in foreign countries, even to the complete cessation of the culture of particular plants of great economic value, has been mainly dependent on particular states of the atmosphere. Coming changes and storms are known to the hardy fishermen of coasts and islands long before the landsmen would discern anything indicating their approach; but instruments prepared by science give warning sooner than even their practice and instinct; and the animals sought for, and for which hundreds of lives are yearly risked, are themselves under atmospheric influence, and come and go as the changes bid them. It is curious, then, that other governments should appreciate the importance of meteorological research, and should support investigation, and that France and Prussia, Austria, Russia, Holland, and America, should all patronize and foster, while the government of Great Britain should stand by, and let private enterprise and private societies take up the subject; and not only stand by, but do so with a perfect apathy, almost even throw discouragement on what so concerns the welfare, and might somewhat regulate the commercial enterprise of the more northern portion of their country. It is true that Her Majesty's government instituted a meteorological department in England, with a grant, to "carry on observations at sea;" and the observatory at

Greenwich has a grant for a similar purpose. Why, then, are the Scotch observations refused to be recognised or moderately assisted? The Registrar-General makes use of the Scotch Society's returns, and publishes them with his tables of mortality and disease. The Hydrographer and surveying officers to the Admiralty avail themselves of the same returns in relation to the time and level of high-water on the Scotch coasts;* and thus their accuracy and value are acknowledged, but nothing has yet been allowed to assist and carry on observations so important and so generally interesting to the people of Scotland.†

We have been rather led away from our object, which was to notice Dr Stark's Address; but the anomaly of the position of a society of such importance, working unaided, almost under discouragement, while its operations were recognised and made use of by government, has carried us into the preceding remarks.

A deputation waited on the Board of Trade in April last, but Mr Henley thought the funds at his disposal were not applicable for Scotch meteorology. Application has been since made to Lord Derby, and it is trusted that common sense and justice will induce government to grant assistance; if not, the Scotch Meteorological Society may cease to exist, as the three years for which the subscriptions were guaranteed have now expired. It was confidently expected, that when the Society was established, and its abilities fairly tested, that it would have received the aid of government; and it asks it now, not as an embryo speculation, but as a society which, as far as its means permitted, has been of use both to the general and scientific public.

Dr Stark's excellent Address gives a summary of the proceedings of the Meteorological Society of Scotland for the past year, with observations drawn from the returns which have been already obtained. In January 1857, returns were made by 48 persons from 36 regular stations; in January 1858, these had been increased to 68 observers at 48 regular stations; and the returns thus obtained, as we have already mentioned, are made use of by the Registrar-General and by the Admiralty.

In treating of a subject, one of the most important within the range of meteorological observation,—the influence of the condition of the atmosphere on health or sickness,—Dr Stark con-

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* The Board of Admiralty have L.1000 allowed to them for "meteorological inquiries."

The annual grants to Societies and Institutions in 1857-8 are:—

England, . . .	L.15,240
Ireland, . . .	31,400
Scotland, . . .	3,963

† The Royal Society of London has a grant from government of L.1000 annually placed at its disposal, to *encourage research and experiment.* Why should the Royal Society of Edinburgh not also have a grant, say L.500, for similar purposes? Are its members less trustworthy, or do they stand lower in the scale of science?

nects it with the increase of temperature and decrease of moisture. Thus, in 1856, during the third quarter, and including July and August, the mean heat was 54°·8′, the fall of rain 10·65 inches, the deaths over Scotland during that period 12·864; while in the same period of 1857 the heat was 58°, rain 7·86, the deaths 14·692; or an increase in the latter of 1·828. The increase in the number of deaths is stated to be chiefly owing to the prevalence of bowel complaints. These are the facts brought out, and they are no doubt true as stated; but the result is perhaps not the true one as a general average over Scotland, as the increase of mortality would probably depend on the town population. We have generally looked upon a high temperature, and dry, or moderately dry weather, as favourable for health in the country; whereas in a town, more particularly if the drainage is at all defective, the very opposite will be the case, from the heat acting on all the impurities of the sewers, and the scanty fall of rain preventing all clearing out. The drinking-water itself often becomes impure, and this is generally accompanied by bowel complaints or other derangements of the system. In this view we may possibly be mistaken; but it would be more correct, we think, to take the town, especially those above a certain population, and the country mortality separately. The great matter is the collection of *facts:* we have too few yet to generalize upon, and without a society and system they cannot be obtained. It is very evident that attention to the state of the atmosphere, and providing for periodical heats and changes, the recurrence of which may be predicted from meteorological experience with great accuracy, become as necessary as a police. As such, it is daily receiving more attention; and in the University of Edinburgh, Dr Laycock devotes some part of his course of lectures to Medical Meteorology.

Another important point in Dr Stark's Address is the theory that storms are periodical, and that, therefore, their appearance may be predicted and consequently guarded against.

"That all our great storms are dependent on, and are integral parts of these atmospheric waves, I think there cannot be a reasonable doubt; and as the causes which give rise to the production of these great waves are not dependent on local influences, we are naturally led to conclude that they must be produced by fixed causes, whose sources have not yet been investigated, but which probably act with as much regularity as the moon on our tides, or the sun on our trade-winds. Should this prove to be the case, then the recurrence of great storms might be predicted with a degree of certainty, of which, till this moment, they have been deemed incapable."

And he continues, "That they recur with regularity at certain fixed periods, I have not the slightest doubt." Two storms are particularly noticed as illustrating this fact in Great Britain: the one occurs from the 19th to the 23d November, and depends on the trough or hollow of the great November atmospheric wave; the other takes place on or about the 7th February, and in proof of the periodicity of the latter the following facts are stated:—In 1843, the greatest depression of the barometer, *and the storm*, occurred upon February 3d; in 1844, on 6th; 1846, on 3d and 6th; 1847, on 6th; 1848, on 9th; 1856, between 5th and 6th; and in 1857, on the 7th. The confirmation of this *periodicity* of storms would be of immense importance; and their recurrence in November and February will now be watched over the whole land.

The mean temperature of Scotland, temperature of the sea, rain-fall, and many other points, are treated of, so far as the observations and returns of the Society bear upon them; and altogether this Address is well worthy the perusal and attentive consideration of our countrymen.

The "Observations in Meteorology," by the Rev. L. Jenyns, is written with the painstaking care which characterizes all the works of that gentleman; whatever he states as a fact may be relied upon. It is, however, of a local value only; and is just an instance of what is often done well privately, but which it is difficult to turn to the general public use, being unconnected with any system or society. Mr Jenyns states—"It is simply an attempt to give a general character of the weather and seasons as noticed in that part of England in which the observations have been made, and to point out the ordinary conditions under which weather-changes seem to take place." It contains a great deal of original observation, and many hints which will assist the meteorologist.

The pamphlet translated by the Board of Trade we have printed entire at p. 50 of this number. The Board has scarcely done it justice in the translation, which we have not ventured to alter materially; and we have printed it to point out the practical applicability of Meteorology to a direct matter of commercial importance.

EXTRACTS FROM CORRESPONDENCE.

Letter from Dr W. Balfour Baikie *to* Dr Christison.

Encampment near Jéba.
River Kwóra, 1*st January* 1858.

Here we have had our mishaps. We lost our ship (The Day-spring) by striking on a sunken rock on the 7th October last, and ever since we have been living in tents and open mat huts. I look upon our living here so long, without losing a man, as a kind of triumph in its way over those who call the African climate so deadly, as we could not have landed under more unfavourable circumstances. Totally unprepared, having to leave the ship at a few minutes' notice; working all the first day on a sandbank or in the water; tired, fasting, depressed at night after the excitement; sleeping on damp ground, having our temporary tent blown in the first night by a violent tornado and ourselves drenched; living for two days in the middle of a marsh; working hard ten or twelve days in a hot sun, in carrying our effects up to a small height; erecting tents and huts; removing things from the wreck, &c.; and having every day or two heavy tornadoes with tremendous rain, and this, too, just as the marshes were beginning to dry up and the river to fall, the most unhealthy period of the year. According to rule, half of us at least should have died. Every one of us had fever; some, as myself, severely, with repeated ague seizures; but here we are alive and well, and hard at work, though without European food, neither wine nor spirits, and living almost entirely on native food. Our drink, until we got a little tea and coffee from Lagos a few days ago, was an infusion of roasted and bruised Indian corn. For sugar we have a very inferior honey, and our night light is from Shea butter, burnt in a rude native lamp. The nicest country dish is a stew of yam and fish, or fowl cooked with fine palm oil, which is most palatable, indeed unusually so. Palm oil is easily digestible, and slightly laxative. A nice evening drink is made by mixing roughly-ground rice with water and sweetening with a little honey. Our vegetables are yam, sweet potato, ochro, and, for those who like them, onions. Our bread is of native ground corn, either maize or zéro. We drink, when good, native beer and palm wine; and our fruits are papaw (*Carica Papaya*), banana (*Musa sapientum*), plantain (*Musa paradisiaca*), and ground-nut (*Arachis hypogea*).

Around this spot we have collected nearly 700 species of plants, and by living ashore and watching them, have got them in different stages. We have discovered several new palms and a real African bamboo. I have several new grains and a numerous collection of fruits, pods, and seeds. By living here so long I have learned much of native products and manufactures, and I am working hard at the Fúlo or Fuláta language, while Mr Crowther has taken up the Núpe, that of the country we are in.

I have had my parties out also, and have had the route from this to Lagos surveyed and opened, and the river as far as Búsa. Our encampment is about twelve miles beyond Rábba. What I gave you as palm kernel oil is not so, but the oil of commerce purified and refined by being twice boiled with water and skimmed off. The kernel oil is of a dark coffee colour, occasionally of a pale brown, and is here chiefly used for burning in lamps, the red refined oil being used for food. The shea butter-tree is abundant here. It is at present in flower, and shows panicles with beautiful white blossoms. We have found two varieties, one being more umbellata in its inflorescence. We have several gums, and have already traced some to their sources; also several native dyes. I am getting sections of many of the palm stems, especially the oil-palm, the Raphia or wine-palm, and the Borassus or fan-palm. Each of these, as well as the coco-palm and date, has a peculiar figure and outline, and can, after a little practice, be easily distinguished. I have also traced all the mats of the natives to their sources, and found out the dyes used for them. We got also an excellent fibre, making a capital rope, from a species of Hibiscus, easily cultivated, and which would form a good commercial article. If I am duly supported, I am so much in the good graces of both chiefs and people along the river, that I could with but little trouble firmly establish British influence, and lay the foundation of a very extensive trade in shea-butter, ivory, palm-oil, cotton, indigo, gum, wax, &c., &c. My zoological collection suffered much by the wreck, and several boxes of good skins and skeletons were ruined; but I am doing what I can to replace them; and, especially in birds, fishes, and insects, I am rapidly advancing. I have already, particularly in the case of fishes, many novelties. I have also some good specimens of reptiles.

We have learned to eat and relish hippopotamus flesh, and some large river tortoises yield excellent turtle soup. So you see we are also attending to the cuisine.

Such, then, is a rapid outline of our proceedings of late. Scarcely a day passes without some novelty or addition to our store, our last one being a pretty purplish-blue Nymphæa. I am now anxiously expecting a steamer to carry us off and enable us to make a fresh start. Our present daily range of temperature (this being the dry season) is from 34° to 38°. Yesterday it was 41°, viz., from 60° to 101° F., and this in a large well-ventilated mat-house. At this moment, with a cool breeze blowing at 12·30 P.M., the thermometer close to me stands at 95°.

WM. BALFOUR BAIKIE.

Letter from Dr HECTOR *to* Professor BALFOUR.

FORT EDMONTON,
SASKATCHEWAN, 5*th January* 1858.

DEAR DR BALFOUR,—I had hoped to have been able to have given you a long account of our movements since I last wrote to you, but I must defer it until I have an opportunity in spring, as the gentleman in charge here is obliged suddenly to send off the winter express this afternoon instead of the 12th, as he intended to do. I have just arrived here alone as regards the rest of our party, who are at Fort Carlton, about 400 miles from this, and where our winter quarters are. Captain Palliser had to return to the civilized world on business during the winter, and he left me in charge, with the work of engaging men, and making other preparations for our trip next year. To do this I have had to make a winter journey with dogs and snow-shoes to this place, to see the principal factor for the Saskatchewan district, and I shall have to continue on to the mountains before I return. I enjoy the winter travelling very much, although at first I found it rather hard work. I am in excellent health, and can stand the running behind the dogs famously. M. Bourgeau has made a very large collection of plants and seeds.

A gathering of the gentlemen in charge of the various trading ports for the New-Years' Day settling of accounts, gave me an opportunity of making further inquiries about Mr Jeffrey the botanist that you wished to hear about, and who has gone amissing. I have seen a gentleman who travelled up to the head water of the Little Fork of Frazer's River on the west side of the mountain, and there he left him. Mr Frazer, who was in charge of Jaspar's House at the time, says he came up in December 1851 along with the winter express, and that he remained at this fort (Edmonton) till February, when he left to cross the mountains on snow-shoes. He remained some time with Mr Frazer at Jaspar's House, and then started to descend the Columbia along with Mr Clouston. I shall try and hear from the latter gentleman what became of him; but he is at present on the west side of the mountains. I shall not give up the inquiry until I hear something positive about his disappearance. All who saw him say he proved a most expert and hardy traveller.

The country here is wooded with poplar and a few pines (*Abies alba*). It is no long time since it was all prairie, but, as seems to be the case everywhere hereabouts, the woods are rapidly encroaching on the bare plain; so that places which were buffalo plains only thirty years ago, are covered with a thick growth of poplar (*P. tremuloides*). The country is divided into two districts by the woods, so well marked, that it gives the character of a variety, not only to all the animals, but even to the Indians. The traders talk of wood Crees and plain Crees; and they are quite distinct in their habits. Then there are wood and plain wolves, buffalo, deer, moose, reindeer, and many other animals, all distinguished generally by the kind which inhabit the woods being the larger, and of solitary habits. The margin of the woodc ountry to the south seems to agree with lat. 54° in this long., but in long. 106° it begins to sweep to the S.E., and reaches lat. 50° at Red River, and even 48°, in Lake Superior, S. of this line. Except close to the base of the mountain there are no woods, save on the N. and N.E. sides of hills, and in the river valleys, on their banks that face the N. This is true, with but few exceptions.

At Carlton we have a rude observatory for magnetical and meteorological purposes, under Lieutenant Blakiston's care, and we all take part in making hourly observations day and night; so that the winter does not hang heavily on our hands.

The weather as yet has been as unusually mild as last winter was severe. The deepest snow does not exceed 1 foot in this quarter; and in some places there is hardly enough to run the dog-sleigh on. The greatest cold as yet has been −17°. The general standing of the thermometer is 15° during the day, and 5° at night. I never feel it so cold as I did at home, although sleeping on the snow in the open air every night. Deferring the rest of my news, of which I have a large stock, until I return to Carlton, and wishing you a very happy new year, I remain, ever yours very sincerely,

James Hector.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday 15th February 1858.—(Continued from last number of Journal.)

3. *Notice respecting some Artificial Sections illustrating the Geology of Chamouni.* By John Ruskin, Esq. Communicated in a letter to Professor Forbes.

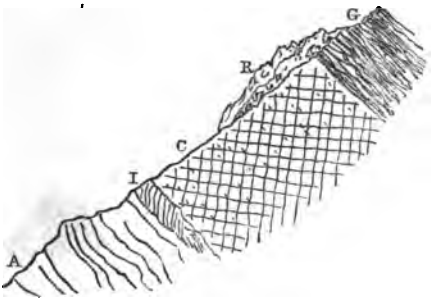
In the Proceedings of the Royal Society, vol. iii., p. 348, an account has been given by Professor Forbes of the discussions which had then taken place as to the geological constitution of the chain of Mont Blanc, and as to the reality of the alleged superposition of the primary rock (gneiss) to the secondary (limestone), near Chamouni, and at Courmayeur.

In order to clear up any remaining doubt, Mr Ruskin caused sections to be made, laying bare the junction at several points of the Valley of Chamouni. The results, which are perfectly accordant with the conclusions of the above-cited paper, have been kindly communicated by Mr Ruskin to Professor Forbes, and are described and sketched by him in the following note. The order of the sections is from the head of the Valley of Chamouni towards its lower or south-western extremity.

Specimens of the more important rocks have been placed in the Museum of the Royal Society:—

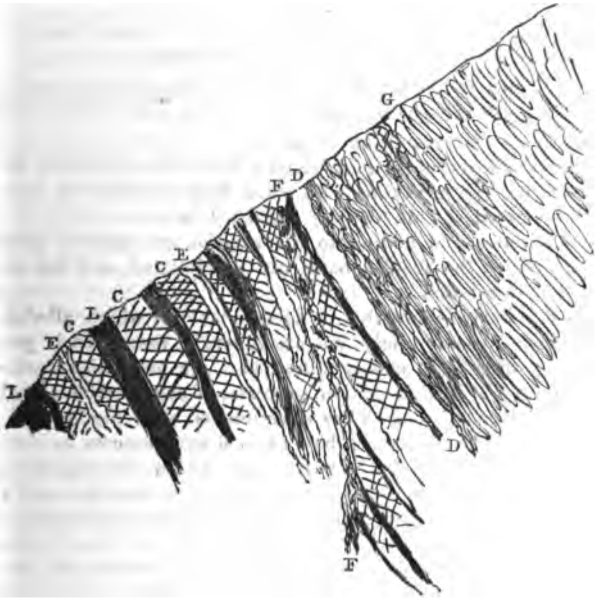
" 1. At Crozzet de Lavanchi, on road to Argentiere, under the Aiguille de Bochard.

" 2. On the road to Chapeau, the same succession of beds takes place, the dip being greater (about 50°); the Buet limestones lower down dipping still more (about 65°). I say 'about,' not as guessing the angle, but giving the average of many accurate measurements.



" A. Black calcareous rocks of the Buet, with belemnites, a good deal contorted (the same rock as at Côte des Pigets).
" I. Imperfect cargneule (porous limestone), about 2 feet thick.
" C. Common cargneule, used for limeworks, &c. (about 50 feet thick at the utmost.)
" R. Debris concealing junction with gneiss.
" G. Gneiss laid bare, striking N. 50 E., and dipping 36° S.E., an unusually small angle, quite accidental and local, the average dip south being much steeper.

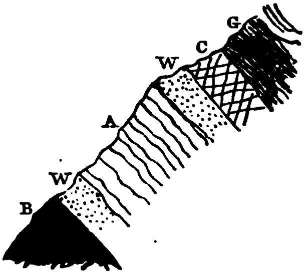
" 3. Junction opposite Prieuré of Chamouni, at my excavation.



" L. Brown limestone, a form of the cargneule.
" C. Cargneule, generally inclosing fragments of the browner limestone, and with bands of greasy green earth, E, E, in the middle of its beds.
" F. Fault filled with fragments of clay and cargneule.
" D. Decomposing white gneiss.
" G. Hard gray gneiss of Montanvert.

"4. At Les Ouches, in the ravine under the Aiguille du Gouté.

" B. Black slates of the Buet.
" W. Pure white fine-grained gypsum.
" A. Buet limestone (A of first section).
" W. Gypsum.
" C. Cargneule (C of first section).
" G. Gneiss.



Monday 1*st March.*—Professor Kelland, V.P., in the Chair.

Professor Kelland, V.P., delivered the Keith Medal, awarded by the Council to Professor Boole of Cork.

The following communications were then read ;—

1. *On the Average Value of Human Testimony,* By Bishop Terrot.

2. *On the Tides in the Sound of Harris.* By Henry C. Otter, Esq., R.N., Captain H.M.S. "Porcupine." Communicated by Dr Stark.

(This paper appeared in last number of this Journal.)

Monday, 15*th March* 1858.—The Right Rev. Bishop Terrot, V.P., in the Chair. The following Communications were read :—

1. *Note on the use of Subacetate of Lead as a means of separating some of the Vegetable Alkaloids.* By Thomas Anderson, M.D., F.R.S.E.

In a paper on the crystalline constituents of opium, read before the Royal Society of Edinburgh, I described a process for separating thebaine from papaverine and narcotine, with which it occurs mixed in the opium liquor I examined. This process consisted in converting the mixed bases into acetates, and adding to the solution an excess of subacetate of lead, by which the feebler bases are precipitated, and the stronger thebaine left in solution.

As it is familiarly known that in those plants in which alkaloids are found, they rarely occur singly, but are generally associated in groups of two or more, often very closely allied in their properties, and consequently require for their separation, processes of considerable complexity, I have been induced to make a few experiments, with the view of ascertaining whether the method I had applied with success to the opium bases could be used for other substances. These observations I offer, not as exhausting the subject, but merely as an indication of a path which may be followed by those engaged in the examination of the natural bases with some prospect of success.

When a dilute solution of acetate of strychnine, containing an excess of acid, is mixed with a saturated solution of subacetate of lead, until its reaction becomes alkaline, and a further quantity of the lead-salt added, the fluid at first remains perfectly clear; but after some time minute crystals of strychnine begin to be deposited, and go on gradually increasing in quantity for four-and-twenty hours. If the solution be highly diluted, the strychnine is deposited slowly, and then appears in very regular crystals, occasionally of considerable size. Concentrated solutions, if violently agitated, are rapidly filled with precipitated strychnine.

If brucine be treated in a similar manner, the solution remains perfectly clear, and, even where violently agitated, no precipitate makes its appearance. At the end of twenty-four hours, the fluid is still clear, although I have once or twice, when the solution was concentrated, observed a few needle-shaped crystals of the base at the bottom of the fluid.

Acetate of cinchonine, in moderately diluted solution, begins to deposit small crystals of the base almost immediately after the sub-acetate is added, and the quantity goes on increasing for some hours. Agitation produces an immediate precipitate.

Quinine is not deposited from its acetate, even on standing during the night, provided the solution be dilute; but if concentrated and briskly shaken, small tufts are occasionally thrown down after standing for some hours.

Morphine and thebaine are not thrown down from solutions of their acetates, even after standing; and codeine, as might be anticipated from its solubility in water, is entirely unaffected. On the other hand, narcotine, papaverine, and narcine, are instantaneously precipitated as bulky powders.

These facts indicate the importance of a more minute attention being paid to the deportment of the vegetable alkaloids with subacetate of lead. We observe that in the case of the two cinchona and the two nux vomica alkaloids, the difference is very marked, and the reaction might be used as a means of separation, and possibly also of purification. Most of the substances found in vegetable extracts, such as gum, &c., are precipitated by subacetate of lead; and in the case of the stronger bases, it might be possible to effect purification by extracting with acetic acid, and precipitating with the subacetate. The strong base would then remain in solution along with excess of lead, which, being precipitated with sulphuretted hydrogen, would carry down colouring matters, and leave a pure acetate in solution. I have not attempted to put this process into practice, but recommend a trial of it to those chemists who are engaged with the examination of the natural alkaloids.

2. *On the Colouring Matter of Persian Berries.* By Mr John Gellatly, Assistant to Dr Anderson, Glasgow.

(This paper appeared in last number of this Journal.)

3. *Account of some Experiments on Radiant Heat.* By B. Stewart, Esq. Communicated by Professor Forbes.

The object of these experiments was to compare together the radiations from the polished surfaces of different bodies, all having the temperature of 212°. In order to heat the bodies, a tin box was used, double-sided and double-bottomed, or a box within a box. Water being kept boiling in the interval, the interior chamber was found to have a temperature of nearly 212°; and on the bottom of this chamber the bodies to be experimented on were placed. When being used, these were taken out of the chamber and placed before the sentient pile of a thermo-multiplier, the galvanometer needle connected with which was immediately deviated from its zero position. The extent of the first swing of this needle was taken to denote the quantity of heat that fell upon the pile, and this deviation taking place in about 12 seconds after the substance had been taken out of the boiling water apparatus, it was found that during this small portion of time the substance might be supposed to keep its original temperature of 212°, its cooling being so small as to be neglected.

In order that different substances might be compared with one another the same amount of heated surface was always presented to the pile.

In the first group of experiments the quantities of heat radiated from polished plates of different substances (heated to 212°) were compared with the quantity radiated from a similar surface of lamp-black at the same temperature. It was found that glass, alum, selenite, and thick mica, radiated very nearly as freely as lamp-black; while the radiation from rock-salt was only 15 per cent. that from lamp-black.

In the second group of experiments the quantities of heat radiated at 212° from polished plates of the same substance, but of different thicknesses, when compared with one another.

It was found that thickness made a scarcely perceptible difference on the quantity of heat radiated by glass, a somewhat greater difference on the quantity radiated by mica, and a very sensible difference on the quantity radiated by rock-salt—a thick plate of this substance giving more than a thin plate, in the proportion of nearly 5 to 3.

The third group of experiments showed that heat from a polished plate of any substance is less transmissible through a screen of the same substance than heat from lamp-black; this difference being exceedingly marked in the case of rock-salt. The same rock-salt screen which transmits ¾ths of the rays which fall upon it from heated lamp-black, transmitting only ⅓d of the rays that issue from heated rock-salt.

The fourth group of experiments showed that heat from a thick plate of any substance is more transmissible through a screen of the same substance than heat from a thin plate.

These four groups of experiments show that the radiation from diathermanous bodies, such as rock-salt, is much less copious than that from bodies of an opposite nature, such as glass; and also that the radiation from diathermanous bodies increases with the thickness of the plate.

It was shown that all these results follow from Prevost's theory of exchanges. For if we suppose a plate of rock-salt placed in a chamber of lamp-black, all at 212°, then, since the temperature of the rock-salt remains the same, it must radiate as much as it absorbs. But since it absorbs but a small proportion of the lamp-black heat, it will radiate but a small proportion, and since a thick plate of rock-salt would absorb more than a thin plate, it would also radiate more.

The radiation of such a thin plate is therefore equal to its absorption.

It was then shown that for every separate ray of which the heterogeneous radiation of 212° is composed this equality must hold; and that for every such ray the absorption of such a thin plate = its radiation.

It was shown that the reason why rock-salt is opaque to heat from rock-salt is this:—There are a few rays out of the total lamp-black radiation of 212° for which rock-salt is opaque; these rays, therefore, are rapidly absorbed by a thin plate of rock-salt; but the radiation being equal to the absorption for every kind of heat, this thin plate will chiefly radiate such rays, which will consequently be stopped by a screen of rock-salt.

In conclusion, it was shown that if we have a chamber, whose walls are composed of different substances, kept at a uniform temperature, the heat radiated and reflected together from any given portion of the surface of its wall will be independent of the nature of the substance of which that surface is composed; the only difference being, that in the case of a metal it will be chiefly reflected and little radiated heat, while in the case of lamp-black it will be altogether radiated heat. But for all substances, radiated + reflected heat = a constant quantity.

Monday, 5th April 1858.—The Right Rev. Bishop TERROT in the Chair. The following Communications were read:—

1. *On the Facets and Corners of Flat-Faced Solids.* By EDWARD SANG, Esq., F.R.S.E.

In this paper it was shown that the usually received theorems concerning the faces of polyhedrons are true only of one class of solids. The theorem, that "*no solid can have every one of its faces more than pentagonal*" was contradicted by the exhibition of a solid bounded entirely by hexagons. Each corner of this solid is trihedral, and the sum of all its angles amounts to four times as many right angles as there are corners; whereas, the usual theorem is, that "*the angles of any solid amount to four times as many right angles as there are corners, less* EIGHT." The number of uniformal solids, that is of solids of which all the faces have the same number of sides, and all the corners have the same number of angles, instead of being *five*, was shown to be indefinite by the exhibition of the solid just mentioned, and of another having each face tetragonal, and each corner tetrahedral.

2. *Biographical Notice of the late Professor Edward Forbes.* By Professor GEORGE WILSON.

Monday, 19th April 1858.—Dr CHRISTISON, V.P., in the Chair. The following Communications were read:—

1. *Notice respecting the remains of a Seal in the Pleistocene of Fifeshire.* By Dr ALLMAN.

Professor Allman exhibited a portion of a pelvis of a seal, which had been recently obtained from the Pleistocene deposits in the neighbourhood of Kirkaldy, and sent to him for determination by Mr Martin Rigney of that place.

From a note received from Mr Rigney, it appears that the bone was found in the Tyrie clayfield, about two miles west of Kirkaldy, and about a quarter of a mile from the shore of the Firth, and that it lay 18 or 19 feet below the surface of the soil, and about 30 feet above the present level of high-water. It was unaccompanied by any other remains.

Mr Page had already noticed the occurrence of a very perfect skeleton of a seal from another locality in Fifeshire; and the great rarity of such remains in the British Isles appeared to Professor Allman a sufficient reason for placing the present instance also on record.

2. *On Theories of the Constitution of Saturn's Rings.* By Professor CLERK MAXWELL.

The planet Saturn is surrounded by several concentric flattened rings, which appear to be quite free from any connection with each other, or with the planet, except that due to gravitation.

The exterior diameter of the whole system of rings is estimated at about 176,000 miles, the breadth from outer to inner edge of the entire system, 36,000 miles, and the thickness not more than 100 miles.

It is evident that a system of this kind, so broad and so thin, must depend for its stability upon the dynamical equilibrium between the motions of each part of the system, and the attractions which act on it, and that the cohesion of the parts of so large a body can have no effect whatever on its motions, though it were made of the most rigid material known on earth. It is therefore necessary, in order to satisfy the demands of physical astronomy, to explain how a material system, presenting the appearance of Saturn's Rings, can be maintained in permanent motion consistently with the laws of gravitation. The principal hypotheses which present themselves are these—

I. The rings are solid bodies, regular or irregular.
II. The rings are fluid bodies, liquid or gaseous.
III. The rings are composed of loose materials.

The results of mathematical investigation applied to the first case are—

1st. That a uniform ring cannot have a permanent motion.

2d. That it is possible, by loading one side of the ring, to produce stability of motion, but that this loading must be very great compared with the whole mass of the rest of the ring, being as 82 to 18.

3d. That this loading must not only be very great, but very nicely adjusted; because, if it were less than ·81, or more than ·83 of the whole, the motion would be unstable.

The mode in which such a system would be destroyed would be by the collision between the planet and the inside of the ring.

And it is evident that as no loading so enormous in comparison with the ring actually exists, we are forced to consider the rings as fluid, or at least not solid; and we find that, in the case of a fluid ring, waves would be generated, which would break it up into portions, the number of which would depend on the mass of Saturn directly, and on that of the ring universally.

It appears, therefore, that the only constitution possible for such a ring is a series of disconnected masses, which may be fluid or solid, and need not be equal. The complicated internal motions of such a ring have been investigated, and found to consist of four series of waves, which, when combined together, will reproduce any form of original disturbance with all its consequences. The motion of one of these waves was exhibited to the Society by means of a small mechanical model made by Ramage of Aberdeen.

This theory of the rings, being indicated by the mechanical theory as the only one consistent with permanent motion, is further confirmed by recent observations on the inner obscure ring of Saturn. The limb of the planet is seen through the substance of this ring, not refracted, as it would be through a gas or fluid, but in its true position, as would be the case if the light passed through interstices between the separate particles composing the ring.

As the whole investigations are shortly to be published in a separate form, the mathematical methods employed were not laid before the Society.

3. *On a peculiar Ligament connecting the opposite Ribs in certain Vertebrata.* By Dr CLELAND. Communicated by Professor GOODSIR.

While examining the bones of a seal which had been for some time in maceration, the author observed that, in detaching one of the ribs from the vertebral column, a long ligament, connected to the head of the former, emerged from the intercostal foramen.

It was then found that the right and left rib in all the pairs articulating with two vertebræ were connected across the mesial plane by a ligament which was attached at each end to a depression on the lower part of the continuous convex cartilaginous surface of the head of the rib, and was lodged in a tube on the floor of the spinal canal, formed by a groove on the upper surface of the corresponding intervertebral disc covered by the superior longitudinal ligament, and lined by a synovial membrane common to the tube, the ligament contained in it, and the entire heads of both the ribs.

It appeared probable that this peculiar transverse intercostal ligament would be found developed in the mammalia directly as the flexibility of the spine.

In the weasel and squirrel it is fully developed; also in the lion, fox, and dog; but in the three latter the single synovial membrane common to the entire arrangement only lines the groove on the superior edge of the intervertebral disc and the under surface of the ligament, the latter being thus in contact above with the superior longitudinal ligament of the spine.

In the sheep and horse the fibres of the anterior half of the ligament are attached midway to the posterior superior margin of the body of the vertebræ in front. In the sheep there are two synovial membranes for the head of each rib,—the posterior on each side communicating across the mesial plane behind the ligament. In the horse there are not only two synovial membranes for the head of each rib, but an intermediate one for the ligament itself.

In the rabbit, fibres extend across from the head of one rib to that of the opposite, but are closely incorporated with the intervertebral disc.

In the kangaroo, monkey, and human subject, there is no trace of the transverse intercostal ligament.

The author is inclined to consider this tranverse intercostal ligament as represented by the transverse ligament of the atlas, and both structures as morphologically related to the perforated form of the intervertebral disc.

The communication concluded with observations on the relative movements of the ribs and spine, in connection with this ligament; and on its probable functions.

4. *On the Movements of the Articulation of the Lower Jaw.* By Dr John Smith. Communicated by Professor Goodsir.

After alluding to the difficulty of determining the precise anatomical configuration of the condyles of the lower jaw, especially in the human subject, the temporo-maxillary articulation admitting of a multiplicity of movements, and these, again, being liable to modification by different accidental and other conditions of relative structures, such as the teeth, &c., the author stated that a general principle would nevertheless be found to prevail, and in general to be distinctly traceable in this joint, whatever might be the modifications existing either in its function or external form.

In man, and many of the mammalia, one essential movement of the lower jaw consists in simply opening and shutting the mouth, in a vertical plane: here the temporo-maxillary articulation is said to act as a *simple hinge.* Another essential motion is that by which grinding of substances between the molar teeth during mastication is performed: here the action of the joint has apparently been regarded as somewhat irregular and subordinate in its nature.

In the first-mentioned movement, however, the condyles cannot act as a *simple hinge,* as they lie, not at right angles to the plane of motion of the lower jaw, but obliquely to it, each condyle looking inwards and forwards. Their more perfect action, therefore, cannot occur in this movement, but seems to belong to the second we have mentioned,—viz., that of mastication.

The articulating surface, strictly speaking, on each condyle appears to constitute the thread, or rather part of the thread, of a conical screw passing over an axis lying at or about right angles to the plane of motion in simple opening and closing of the jaws. This spiral course of the articular surface is perhaps best seen in some of the larger carnivora, such as the lion, but is also obvious in a well-developed human condyle.

The action of this conical screw or tap within the glenoid cavity, considered as the conical die, takes place with accuracy only when one joint alone acts with the condyle within the glenoid cavity—the other condyle being beyond it, and gliding upon the surface of the zygoma, as during mastication. The food is in this process crushed between the molar teeth of that side whose condyle remains within the glenoid cavity; this condyle screwing the jaw back, so to speak, to its natural position at each closure of the teeth.

By this construction a great amount of friction is avoided; what would otherwise be a *rubbing* being thus converted into a *rolling* motion between the condyloid and glenoid surfaces; while by one or other condyle always remaining in the glenoid cavity during mastication greater steadiness and security is afforded to the joint.

5. *On some properties of Ice near its Melting Point.* By Professor Forbes.

"During the last month of March I made some experiments on the properties of ice near its melting point, with particular reference to those of Mr Faraday, published in the 'Athenæum' and 'Literary Gazette' for

June 1850, to which attention has been more lately called by Dr Tyndall and Mr Huxley in relation to the phenomena of glaciers.

"Owing to indisposition, I have been obliged to leave my experiments for the present incomplete. But I am desirous, before the session of the Royal Society closes, to place on record some facts which I have observed, and also some conclusions which I deduce from these and other recent experiments and discussions.

"Mr Faraday's chief fact, to which the term 'regelation' has been more lately applied, is this, that pieces of ice, in a medium above 32°, when closely applied, freeze together; and flannel adheres apparently by congelation to ice under the same circumstances.

"1. These observations I have confirmed. But I have also found that metals become frozen to ice when they are surrounded by it, or when they are otherwise prevented from transmitting heat too abundantly. Thus, a pile of shillings being laid on a piece of ice in a warm room, the lowest shilling, after becoming sunk in the ice, was found firmly attached to it.

"2. Mere *contact*, without *pressure*, is sufficient to produce these effects. Two slabs of ice, having their corresponding surfaces ground tolerably flat, were suspended in an inhabited room upon a horizontal glass rod passing through two holes in the plates of ice, so that the plane of the plates was vertical. Contact of the even surfaces was obtained by means of two very weak pieces of watch-spring. In an hour and a half the cohesion was so complete, that, when violently broken in pieces, many portions of the plates (which had each a surface of 20 or more square inches) continued united. In fact, it appeared as complete as in another experiment where similar surfaces were pressed together by weights. I conclude that the effect of pressure in assisting 'regelation' is principally or solely due to the larger surfaces of contact obtained by the moulding of the surfaces to one another.

"3. Masses of strong ice, which had already for a long time been floating in unfrozen water-casks, or kept for days in a thawing state, being rapidly pounded, showed a temperature 0°·3 Fahrenheit below the true freezing point, indicated by delicate thermometers (both of mercury and alcohol), carefully tested by long immersion in a considerable mass of pounded ice or snow in a thawing state.

"4. Water being carefully frozen into a cylinder several inches long, with the bulb of a thermometer in its axis, and the cylinder being then gradually thawed, or allowed to lie for a considerable time in pounded ice at a thawing temperature, showed also a temperature decidedly inferior to 32°, not less, I think, than 0°·35 Fahrenheit.

"I think that the preceding results are all explicable on the one admission, that Person's view of the gradual liquefaction of ice is correct (*Comptes Rendus*, 1850, vol. xxx. p. 526),* or that ice gradually absorbs latent heat from a point very sensibly lower than the zero of the centigrade scale.

"I. This explains the permanent lower temperature of the interior of ice.

"Let AB be the surface of a block of ice contained in water at what is called a freezing temperature. That temperature is marked by the level of the line QP above some arbitrary zero. LM is, in like manner, the permanent but somewhat lower temperature possessed by the interior of the ice. The space, partly water, partly ice, or partaking of the nature of each, MNOP, has a temperature which varies from point to point, the portion NO corresponding to what may be called the physical surface of the ice between AB and *ab*, which is 'plastic ice,' or 'viscid water,' having the most rapid variation of local temperature.

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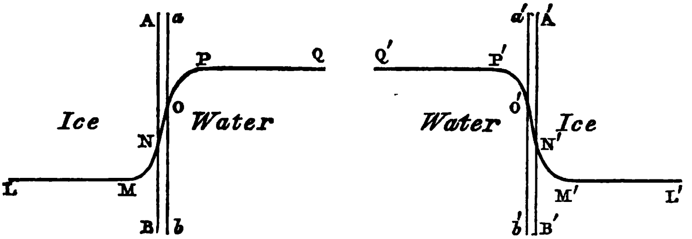
* Quoted by me in 1851, in my sixteenth letter on Glaciers.



"II. Such a state of temperature, though it is in one sense permanent, is so by compensation of effects. Bodies of different temperatures cannot continue so without interaction. The water *must* give off heat to the ice, but it spends it in an insignificant thaw at the surface, *which therefore wastes, even though the water be what is called ice cold*, or having the temperature of a body of water enclosed in a cavity of ice.*

"This waste has yet to be proved; but I have little doubt of it; and it is confirmed by the wasting action of superficial streams on the ice of glaciers, though other circumstances may also contribute to this effect.

"III. The theory explains 'regelation.' For let a second plane surface of ice A′B′ be brought up to nearly physical contact with the first surface AB. There is a double film of 'viscid water' isolated between two ice surfaces colder than itself. The former equilibrium is now destroyed. The films AB*ba* and A′B′*b′a′* were kept in a liquid or semi-liquid state by the heat communicated to them by the perfect water beyond. That is now removed, and the film in question has ice colder than itself on both sides. Part of the sensible heat it possesses is given to the neighbouring strata which have less heat than itself, and the intercepted film of water in the transition state becomes more or less perfect ice.

"Even if the second surface be not of ice, provided it be a bad con-

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"* I incline to think that water, in these circumstances, may, though surrounded by ice, have a fixed temperature somewhat higher than what is called 32°. But I have not yet had an opportunity of verifying the conjecture.

"[My idea is, that the invasion of cold from the surrounding ice is spent in producing a very gradual 'regelation' in the water which touches the ice, leaving the interior water in possession of its full dose of latent heat, and also of a temperature which may slightly exceed 32°. By similar reasoning, a small body of ice, inclosed in a large mass of water, will preserve its proper internal temperature *below* 32°; but, instead of regelation taking place, the surface is being gradually thawed. This is the case contemplated in the paragraph of the text to which this note refers.]"

N.B.—*The words in brackets were added to this note during printing.* 13*th May* 1858. J. D. F.

ductor, the effect is practically the same. For the film of water is robbed of its heat on one hand by the colder ice, and the other badly conducting surface cannot afford warmth enough to keep the water liquid.

"This effect is well seen by the instant freezing of a piece of ice to a worsted glove, even when on a warm hand. But metals may act so, provided they are prevented from conveying heat by surrounding them with ice. Thus, as has been shown, metals adhere to melting ice."

Royal Physical Society.

Wednesday, 24th March 1858.—William Rhind, President, in the Chair.

The following communications were read:—

1. *Remarks on* Lutraria elliptica. By George Lawson, Ph.D.

After alluding to the general distribution of this species of shell, which occurs as a fossil in the Coralline crag, as well as on our coasts in the present day, Dr Lawson mentioned that he had collected the animal in a living state on the east coast of Forfarshire, near the mouth of the Tay, where it is thrown up in immense quantities by strong easterly gales.

2. *On Monœcious Reproduction in* Tubularia larnyx. By T. Strethill Wright, M.D.

The author described the polyp of this zoophyte. He stated that its reproductive capsules were produced on branches arising from the buccal papilla, and consisted both of males and females on the same branch. These capsules were each furnished with four tentacles, which caused them to resemble young polyps, but the true young were inclosed within the female capsules, while the male capsules contained spermatozoa.

Dr Wright exhibited to the society the *Hydra tuba* of Sir J. Dalyell undergoing the process of change into medusæ. The specimen brought before the meeting was at least four years old, having been in captivity for that length of time. Within the last week it had become elongated into a fleshy cylinder, which was marked with thirteen transverse striæ. The intervals between the striæ became lobed, and were gradually developed into a chain of medusæ, packed together like a pile of saucers. The upper medusæ of the pile were already free and flapping about in the water. Sars had traced the further development of these medusæ into *Medusa aurita*, the large jelly-fish of the Frith of Forth.

Dr Wright was also enabled, by the kindness of Mr Alder of Newcastle, to place before the Society several rare zoophytes, amongst which was the *Myrothela artica* of Sars. He stated that the animal was not naked, as described by Gosse, but had a distinct horny corallum; nor were its tentacles wart-shaped; they resembled the tentacles of Corvne, except in having sting-cells of smaller size. He stated that, according to Mr Cocks of Falmouth, the young of Myriothela was furnished with long processes or *legs*, on which it moved from place to place as its erratic fancy led it. But after some time it forsook its wandering life, cast off its *legs*, developed tentacles, fixed itself to a stone, and devoted itself to the more staid occupations of providing itself with food, producing a family of young ones, and stinging those of its marine neighbours who came into collision with it.

3. *Report of an Expedition undertaken to Explore a Route by Rivers Waini, Barama, and Cuyuni, and the Gold-Fields of Caratal, and thence to the River Orinoco, South America.* By W. R. Holmes, Esq., and W. H. Campbell, LL.D. Communicated by Professor Balfour.

4. *On the Spiral Threads of the* Helix aspersa. By John Cleland, M.D.

In this communication on the spiral thread formed by the *Helix aspersa,* Dr Cleland showed that this structure was developed in the long tubule which opened into the duct of the so-called purple sac, and that the tubule communicated with the upper end of the uterus. He concluded that the dried albumen, of which the spiral thread consisted, was furnished by the albumen gland.

5. *Note on the Cuckoo,* Cuculus canorus. By John Alex. Smith, M.D.

On the 20th of last May, Dr Smith dissected a male cuckoo, in full adult plumage, which had been shot in this neighbourhood a day or two before. The stomach, a musculo-membranaceous bag, with the proventriculus well defined, measured two inches in length and one and a-half inches across, or in breadth; it appeared to contain a firm, rounded body, lying loosely in its otherwise empty cavity. On opening the stomach, the proventriculus was found filled with a mucous secretion, and a black oval-shaped body was seen, of a smooth and lubricated appearance; it measured one inch in length and about half an inch in breadth, and weighed 31 grains. When broken across, it was found to be of a lighter colour, and nearly dry internally, and consisted apparently of the undigested remains of insects and larvæ, portions apparently of elytra, vessels, &c. It was evidently the indigestible parts of the food prepared for being ejected from the stomach by the mouth,—a "pellet" or "cast," as it has been called, which is so well known in the case of the hawks and owls; and from the abundant secretion in the proventriculus, and empty state of the stomach, was apparently on the very point of being ejected by the mouth. The fact was new to him as regarded the cuckoo, and he therefore noted it with considerable interest. The lining membrane of the stomach showed no appearance, either to the naked eye or to the microscope, of the coating of hair, which has been often described, and which he had seen in other specimens; it is believed to be caused by the bird feeding on hairy caterpillars, perhaps at a more advanced period of the season; the intestines contained only a uniform smooth creamy-like matter. The testes were very small, being scarcely one-fourth of an inch in length, the largest like a very small pea. Several genera of birds, it is well known, eject the indigestible parts of their food as pellets. Sir William Jardine believes, that in addition to the Accipitres, the cuckoos, king-fishers, motmots, and bee-eaters all do so. Macgillivray says,—"I have never met with a fragment of the elytra, the articulation of a limb, or any other hard part of an insect in the intestines of the cuckoo, the contents of which are of a uniform pulpy and impalpable mass of a light red colour. Of course, the remains of insects in the stomach must be thrown up in pellets as in hawks and owls." He was able, therefore, to supply the positive side of the evidence, and by exhibiting the pellet from the stomach itself, put an end to any doubt that might have existed on the subject, at least in regard to the cuckoo.

Wednesday, 28th April 1858.—ANDREW MURRAY, President, in the Chair. The following Communications were read :—

1. *Notice of Coal found in the Primary Slate of Easdale, Argyleshire.* (Specimens were exhibited.) By WILLIAM RHIND, Esq.

2. *Remarks on a Baleen Whale captured off the Bell Rock on the 7th of September* 1857. By JAMES M'BAIN, M.D., R.N.

3. *Observations on British Zoophytes.*—(1.) *On* Atractylis (*new genus*); (2.) *On the fixed Medusoids of* Laomedea dichotoma (living specimens were exhibited); (3.) *On the Reproductive Organs of the Medusoid of* Laomedea geniculata; (4.) *On the Reproductive Organs of* Laomedea lacerata. By T. STRETHILL WRIGHT, M.D.

4. *A few remarks on* Lamellaria tentaculata, *and its Nidification, &c., as observed at Wick.* By CHARLES W. PEACH, Esq.

Mr Peach's communication detailed his discovery of the *Lamellaria tentaculata* in considerable abundance on the sea-coast at Wick, and also the curious fact of its leaving in the spring the deeper water of the Laminarian zone, which is its usual habitat, and seeking a temporary residence nearer the shore, when both itself and nidus are left uncovered by every ebb tide, and its excavating hollows in the *Leptoclinum punctatum* (" British Mollusca," Vol. I.), in which it forms its nests and deposits its eggs in yellow rounded masses. He gave details of its development in the nest, and described the appearance of the embryos, illustrating the whole with drawings. The *Lamellaria tentaculata* is considered to be rare, and previous to Mr Peach's discovery had not been observed farther north than Cullercoats, where it is noticed by Mr Alder. [Mr James Macdonald, Academy, Elgin, has since informed Dr Smith that the *L. tentaculata* also occurred in considerable abundance in that neighbourhood.]

(2.) *A notice of Natural Printing of Sea-weeds on the rocks in the vicinity of Stromness, Orkney.* (A specimen was exhibited.) By CHARLES W. PEACH, Esq., Wick.

5. Dr SMITH exhibited a male specimen of the *Raia spinosa*, the Sandy Ray of Cornwall, where it was first observed by Mr Couch. It had also been taken off the coast of Ireland, as mentioned by Mr Yarrell, who figures it in the second volume of his "British Fishes." The fish on the table measured 2 feet in length to the point of the tail, and 1 foot 2½ inches broad. Dr Smith was also informed by Mr Macdonald, Elgin, that the *R. spinosa* had been several times taken on the adjoining coast.

6. *Granite found* in situ *in Mid-Lothian.* By MR GEORGE FORREST.

Mr Forest exhibited specimens of a compact gray granite, in colour much like that found at Aberdeen, which had been lately discovered *in situ* near Esperston. Mr W. A. Jardine, C.E., and he, had visited the place, and it appeared to exist in considerable quantities. He made some remarks as to the importance of the discovery in an economical point of view, and at so short distance from the city. It appeared that Mr Pringle, Garvald, in excavating for materials to build stone dykes, had recently exposed the rock near Carcant Nick, on the road from Fushie Bridge to Innerleithen, where it seems to form the principal part of the hill of Broadlaw, stated in the Ordnance Survey Map at 1414 feet in height; the strata, described as that of greywacke, being exposed on its side in nearly a vertical position.

7. *Notes on some Experiments recently made on the Preservation of certain Marine Radiata.* (Numerous preserved specimens were exhibited). By Mr James B. Davies.

8. *Notice regarding the Food of* Patella vulgata, *&c.* By John Alex. Stewart, Esq., Lochcarron. Communicated by Andrew Murray, Esq.

9. *Dumfriesshire Graptolites, with Descriptions of several New Species.* (A collection of these fossils were exhibited.) By Mr William Carruthers.

10. Mr John Livingstone exhibited a fine specimen of the *Poterioceras ventricosum* of M'Coy, which was obtained by him in August 1854, from the carboniferous limestone beds quarried at Turniedykes, near Gorebridge. He considered it to be the first instance of this fossil having been noticed in Scotland.

Botanical Society of Edinburgh.

Thursday, 11th March 1858.—Professor Balfour, V.P., in the Chair. The following papers were read:—

1. *A few Remarks on the Application of Photography to Botanical Purposes.* By Charles J. Burnett, Esq.
2. *Critical Remarks on the Genus* Orthotrichum. Part II., with Illustrations. By Dr Benjamin Carrington, Yendon, by Leeds. Communicated by Dr George Lawson.
3. *Recent Botanical Intelligence.* By Professor Balfour.
   (1.) *On the Gutta Percha Plant of Surinam.*
   (2.) *On the Vegetation around the Volcanic Craters of the Island of Java.* By M. H. Zollinger.
   (3.) *On the Lotus or Sacred Bean of India.* By Dr Buist.
   (See the number of this Journal for April 1858, pp. 319-324.)

Thursday, 8th April 1858.—Dr Seller, President, in the Chair. The following communications were read:—

1. *Description of* Narthex Assafœtida, *Falconer, at present in flower in the Royal Botanic Garden.* By Professor Balfour.

Dr Balfour stated that since the time of Kæmpfer, who visited Persia in 1687, Assafœtida had been known to be the produce of an umbelliferous plant. Several species of plants have been supposed to yield this article of Materia Medica. Dr Christison states that it is probable that assafœtida is obtained from at least two distinct species,—1, *Ferula Assafœtida of* Linnæus, *or Narthex Assafœtida of* Falconer; and, 2, *Ferula persica* of Willdenow. Both these plants have been cultivated in this country for some time. A root of the latter plant was sent to Edinburgh as the true Assafœtida plant, by Pallas, from the mountains of the province of Ghilan, in the west of Persia. It was cultivated in the Edinburgh Botanic Garden by Dr John Hope in 1786. The plant has flowered and fruited frequently in Britain. The former has never done so until the present year, when two specimens have pushed forth flowering stems in the Botanic Garden. The plant was found by Kæmpfer growing in the province of Laristan, towards the Persian Gulf, not far from Gambroon; and he also states that the plant grows on the eastern confines of Persia and the province of Khorasan near Herat. Since Kæmpfer's day it has been found in various parts of Persia by European travellers.

The following statement is given by Dr Christison as to the seeds sent to this country:—"In 1839 seeds of the Herat plant were received in this country from Sir John M'Neill, who visited the district, and saw the plant growing. In 1838, Dr Falconer saw the same plant growing in the valley of Astore, to the north of Cashmere, and afterwards cultivated it in the Saharunpore Botanic Gardens. In 1840, another locality was found by the expedition of Lieutenant Wood to the sources of the Oxus. This is situated in Syghan, near the western termination, and on the northern slope of the Hindoo Coosh range of mountains, about twenty miles north of Bameean."

"Seeds were sent to the Edinburgh Botanic Garden both by Sir John M'Neill and Dr Falconer, and were carefully reared by Mr William M'Nab the superintendent. In 1842 these seeds germinated, but the shoots merely appeared above ground, and then seemed to die. Mr M'Nab, however, did not give them up for lost. He would not allow the earth under the frame to be dug up, and determined to give them another year's trial. Accordingly, next summer new shoots appeared, and from them the present stock of plants in the garden has been derived. Ever since that time the plants have sent up a vigorous crown of leaves in early spring, but these have withered by midsummer, without any symptoms of flowering. The crown of the roots continued, however, to increase annually, and in some of the specimens attained a diameter of four inches."

We have looked yearly for the production of flowers in vain, until the present spring, when two plants which had been transplanted in the spring of 1857, showed evidence of pushing up a flowering axis. At first the shoots consisted entirely of an axis covered by large yellowish-green membranous sheaths. In this form it reached the height of 1 to 2 feet. Then flowering branches began to show themselves in the axils of these sheaths, which are the enlarged petioles or pericladia embracing the stems and covering the flowering buds. In the lower part of the axis these sheaths are terminated by leaves of a much smaller size than the ordinary leaves of the plant, but having the same pæony-leaf-like form. As we proceed upwards on the axis the size of the laminæ diminish, and ultimately at the upper part the sheaths alone are developed. These also become smaller as we reach the terminal umbels. In one of the plants there are no such leaves, in the other there are a few, thus resembling the figure given in Kæmpfer's work. In that figure the sheaths do not present the conspicuous appearance which they do in the plants now in flower in the garden. Professor Balfour then proceeded to detail the generic and specific characters, filling up the description which had been given by Dr Falconer in "Royle's Materia Medica," and making one or two alterations. He stated that the colour of the flower is yellow, that the sheaths are not all aphyllous or leafless, and that the petals have an ovate form, without an acuminated point. Barren flowers, bearing stamens only, occur in peculiar rounded umbels below the fertile umbels. In these flowers the petals have a peculiar oblique and unequal form. The characters taken from the fruit could not be perfectly given in the present state of the plant. Perhaps the peculiar summer of 1857 may have had some effect in maturing the plant.

Mr M'Nab gives the following notice of the plants now in flower:—

"The large plant of *Narthex Assafœtida*, now in flower in the Botanic Garden, was lifted from a glazed pit where it had been growing vigorously for the last five years. An alteration in the pits rendered it necessary to remove the plant to its present site. This was done on the 10th of March 1857. At the time of removal, the leaves were begining to unfold, and continued to do so freely throughout the spring months. The plant has always been protected with glass during winter. On the 15th of February of the present year it showed symptoms of flowering, appearing at first like a large round ball of a greenish-yellow colour, having a few short leaves rising from it. On the 19th of March the plant had assumed a peculiar club-shaped appearance, 21 inches high and 15 inches in circumference at top. About the 22d of March the sheaths began to unfold themselves and expose the dense clusters of flowers, and at this stage the daily growths became most conspicuous.

From 8 A.M. of the	22d	March	to 8 A.M. of the	23d,	growth	4	inches.
Do.	23d	do.	do.	24th	„	4½	„
Do.	24th	do.	do.	25th	„	4½	„
Do.	25th	do.	do.	26th	„	3½	„
Do.	26th	do.	do.	27th	„	2½	„
Do.	27th	do.	do.	28th	„	1½	„
Do.	28th	do.	do.	29th	„	5½	„
Do.	29th	do.	do.	30th	„	6½	„
Do.	30th	do.	do.	31st	„	2½	„

At the present time the upright growth has nearly ceased, while the lateral branches (29 in number) are daily increasing in length. This day, 7th April 1858, the plant is 5 feet 7 inches high, and the branches 36 inches in diameter of spread."

The Assafœtida plants grow in a very dry climate. Besides the gum-resin, Falconer states that the fruit of the *Narthex Assafœtida* is imported into India from Persia and Affghanistan, under the name of Anjoodan, being extensively employed by the native physicians in India. Anjoodan is the term applied to the seed of Heengsch or Hingisch, or Hulleet, by Avicenna, also quoted by Kæmpfer, and used by the Indo-

Persian and Arabic writers generally in describing the Assafœtida plant.

Falconer thinks that the fruits sent by Sir John M'Neill from Persia were not those of Narthex.

Assafœtida is got by incision into, or slices taken from, the tip of the root. The whole plant has a strong garlic odour.

The communication was illustrated by a flowering branch of the plant, with its leaves and sheathing petals, as well as by photographs taken by William Walker, Esq. F.R.C.S.E.

2. *Recent Botanical Intelligence.* By Professor **Balfour.** (1.) **Braun** on Parthenogenesis.

Dr Balfour gave a rapid sketch of the progress of vegetable embryogeny, from the times of Grew, Ray, Camerarius, Linnæus, and Morland, up to the present day. He then gave an abstract of Dr Braun's statements in regard to Parthenogenesis, or the production of perfect seed without the agency of pollen.

The doctrine of reproduction in plants and in animals by the agency of two sexes, has been so generally received, that it has become a physiological character in the organized kingdom of nature. Of late years, however, facts have been produced, which seem to prove that reproduction may take place in certain instances without fecundation. To this Siebold has given the name of Parthenogenesis, or virgin-birth. This has been demonstrated in a very interesting manner by Siebold, in the case of bees, and of some butterflies (Wahre Parthenogenesis bei Schmetterlingen und Bienen, von Th. von Siebold, 1856). Various experiments have also been made on diclinous, especially monœcious plants, which seem to show a similar mode of production in the vegetable world. The earliest observations appeared to be so completely at variance with the received doctrine of science, that they were discarded, and the facts, as narrated, were referred to some error or fallacy in the experiment. The difficulty of isolating the flowers of plants, and preventing the contact of a single grain of pollen, was so great, that botanists were cautious in giving assent to the facts which seemed to be proved by the experiments. These remarks apply to the observations of R. J. Camerarius in 1694, of Spallanzani from 1767 to 1779, of Henschel in 1817–18, of Girou de Buzareingues in 1827 to 1833, of Ramisch in 1833–38, and of Bernhardi in 1834–39. Within the last few years, however, the experiments of Tenore, Gasparrini, Naudin, and Smith of Kew, seem to place the doctrine of vegetable parthenogenesis beyond doubt.

The following are the plants on which the most direct and positive observations have been made:—

A. *Diœcious Plants.*

1. *Cannabis sativa,* common hemp.
2. *Spinacia oleracea,* common spinach.
3. *Lychnis dioica,* common campion.
4. *Mercurialis annua.*
5. *Bryonia dioica,* bryony.
6. *Datisca cannabina.*
7. *Pistacia narbonensis,* and other species of the genus.

B. *Monœcious Plants.*

8. *Cucurbita Melopepo*, and other species of the genus.
9. *Cucurbita Citrullus*, water melon.
10. *Urtica pilulifera*, Roman nettle.
11. *Ficus Carica*, fig.

All the observations, however, made on these plants have not been rigorously demonstrative, inasmuch as due precautions have not in all instances been taken to prevent the access of pollen from some extraneous source, nor to determine whether or not some male flowers may not have appeared among the female ones. At the same time, it must be admitted, that when such careful and able observers as Spallanzani, Bernhardi, Naudin, and Thuret, deduce the same results from experiments made without any preconceived ideas, their opinion bears strongly in favour of the existence of parthenogenesis.

In order to put the matter beyond doubt, Braun remarks, it was necessary that we should have an exotic diœcious plant of which there was only female and no male specimens in our gardens, and in which it could be shown that there was no tendency to produce male flowers among the female ones. These conditions seem to be fulfilled by the plant called *Cælebogyne ilicifolia.*

In 1829, Allan Cunningham sent to the garden at Kew three specimens of a small shrub, with holly-like leaves, which he had found growing abundantly in the forests of the Brisbane River at Moreton Bay. The plant produced female flowers, and was found to be Euphorbiaceous. It first received the name of *Sapium ilicifolium* and subsequently of *Cælebogyne ilicifolia.* The plant was found to have produced perfect seeds, in circumstances where pollen could not have come into contact with the pistil. The plants produced by the seeds were in every respect similar to the parent.

Since Mr John Smith's first observations at Kew opportunities have been afforded of experimenting carefully on the plant; and after twenty-seven years' observations, the fact, as stated by Mr Smith, appears to be confirmed.

In the Berlin gardens similar observations have been made, and the results are confirmatory of those at Kew. In all cases female plants have been produced similar to the parent, and seeds have been perfected without the contact of pollen. Some of the seeds have been found by M. Braun to contain no albumen nor embryo, while others were perfect in every respect.

The question then comes to be, How are these seeds perfected?

1. Is there any fecundation in the plant by means of the glandular bodies, or otherwise?

2. How is the embryo formed, and what phenomena precede and follow its development, as compared with what takes place where pollen intervenes?

3. Is the Cælebogyne really a plant of a single sex, as it appears to be in our gardens; or, if there are two sexes in its native country, what are the numerical relations of the individuals of each sex in the case of fertility without previous fecundation, and in the case in which the embryo is the necessary consequence of fecundation?

As regards the first question, it may be remarked, that effective fecundation without anthers or pollen is contrary to all probability among Phanerogams. M. Braun has examined the glands which occur on the external surface of the bracts, and has not been able to detect anything different from the glands of other Euphorbiaceæ.

As to the second question, M. Braun gives observations by M. Th. Deecke on the production of the embryo, in which he shows that the embryo follows the usual course of development in angiospermous Phanerogams, with the exception of the absence of the pollen tube. Radlkofer confirms these statements from observations made on more than twenty ovaries of the plant at Kew. The germinal vesicles which appear are either two or three, one of which comes to perfection. Thus, says M. Braun, these observers plainly point out this as a case of true vegetable parthenogenesis. The stigma of the plant remains for a long time fresh, and even increases during the enlargement of the ovary. This is contrary to the ordinary phenomenou, when, after contact with the pollen, the stigma withers and dries up. This fact has also been confirmed by Messrs Naudin, Thuret, and Decaisne, in their observations on the production of seeds without fecundation, in the hemp, and *Mercurialis annua.*

As to the third question, whether *Cœlebogyne* has only one sex, it is stated that Sir William Hooker has in his herbarium male specimens collected by Allan Cunningham. These have been examined by Braun, and Decaisne, and have been found to possess normal stamens filled with perfect pollen.

It therefore appears that Cœlebogyne is a diœcious plant, which produces seeds by parthenogenesis, as well as by the agency of sexes. But we cannot at present conjecture what relation these two modes of reproduction bear to each other, and what is the bearing of parthenogenesis on the vital economy of the plant. If it is shown that without fecundation the plant only produces female individuals, which is the case in gardens at present, we may ask if this mode of multiplication is indefinite, or if it ceases after a determinate series of generations; or, finally, if, after a series of female generations, it will produce male individuals.

The other plants in regard to which parthenogenesis has been proved do not furnish any facts which can aid us in replying to these questions, seeing that their unfecundated seeds produce up to the fourth and fifth generations both male and female plants.

M. Braun thinks that parthenogenesis also can be shown to occur in some diœcious species of Chara, as in *Chara crinita.*

In Characeæ there exist reproductive organs of both sexes. In them sporangia and antheridia have been detected. Most of the Characeæ are monœcious, and some are diœcious. Among these diœcious species may be noticed *Chara aspera* and *crinita, Netella syncarpa, capitata,* and *opaca.*

Chara crinita was first described and figured by Wallroth in 1815. This species is distinguished from all its congeners by the fact that the number of the series of cortical cellules of the stem is equal to that of the leaves which form a verticil, and the number of the same cellules in the leaves is equal to that of the secondary verticillate leaflets, which are usually called bracteæ; whilst in the other Charas the number is double or triple that of the parts which compose each verticil.

The geographical distribution of this species is less extensive than that of most of the others. It is found only in Europe, in Middle Asia, and in Northern Africa. It delights in saline or brackish water, and is found chiefly near the sea or in countries possessing salt springs, or ground impregnated with salt.

Although *Chara crinita* is said to be diœcious, yet we seldom can detect antheridia. M. Braun has in vain attempted to find these organs; and he arrives at the conclusion, that the *Chara crinita*, so far as he can ascertain, is usually represented only by female individuals, and that, nevertheless, it produces in abundance sporangia and fertile spores. M. Requien has very recently detected male plants at Courtheson, near Orange, and these, when examined, were found to bear antheridia. It would appear, then, that in certain localities the *Chara crinita* is represented by two sexes, whilst in general it is only represented by one.

The spores in the species of Chara follow the same development as in monœcious species, having both antheridia and sporangia.

Braun concludes that, on the supposition that the antheridia in Characeæ are true male organs, and that the antherozoids in them serve for fecundation, and that the spore formed in the sporangia is the true female organ, which is fertilized by contact with the antherozoids, he is justified in attributing to *Chara crinita* the power of producing, at least in certain localities, even without the action of male organs, perfectly-formed spores fit for germination, and that consequently this is a true case of parthenogenesis.

(2.) *M. Auguste Trécul on the Circulation of Plants.*—M. Trécul endeavours to show that the absorption by the roots, and the movements of fluids in plants, cannot be accounted for by capillarity and endosmose. Physiologists allow that these forces cannot carry the fluid to the summit of our trees without the aid of the evaporation from the leaves, which, as it were, draws the fluids to these organs. If evaporation makes the fluids ascend, Trécul thinks that it should prevent them from descending.

If we allow that endosmose causes the fluids to ascend by the wood and descend by the bark, then it follows that the density of the sap must go on augmenting in proportion as we ascend; it must increase in passing through the leaves from the woody part to the bark, and in descending from cell to cell in the interior of the cortical tissue. Mere gravity cannot account for the descent of the sap, when we reflect that the descent takes place in pendulous branches.

Botanists who admit the endosmotic theory, have not considered that there must be two currents of fluids of different densities by the side of each other; that the ascending sap being less dense than the descending, must be attracted by the latter, since the membranes are permeable; that there must be throughout the whole length of the trunk a horizontal centrifugal current, until an equilibrium of density has been produced; and that then the double current of ascending and descending sap can no longer exist. The descending current, at least, would cease. Another force, therefore, seems to regulate the absorption of fluids from the soil, similar to that which regulates the absorption of gases from the atmosphere. Moreover, there are in plants other movements besides that of the ascending and descending sap. The sap communicates to the cells, during its progress, the substances required for their nutrition.

The cells assimilate the matters which are suitable for them, and reject others. The rejected elements are taken up, according to Trécul, by the laticiferous vessels, or are collected into special reservoirs, as essential oils, &c. In these reservoirs there is not a denser fluid for which these oils have an affinity. Hence, then, endosmose seems to have no share in the movements.

The cellules on the surface of roots take up fluids by a vital force which we cannot explain, says Trécul. These fluids are carried to the woody parts of the root, and then of the stem; they reach the leaves, and then descend towards the roots, describing thus a kind of circle. This circulation may be called the *grand circulation;* while the *venous* circulation is that which, by means of the laticiferous vessels, carry back to the vessels, properly so called, the substances which the cells have not assimilated. There, is, besides an intra-cellular movement in many plants, to which the name of *rotation* has been given, as the fluid seems to perform a revolution with more or less regularity in the interior of each cell.

During vegetable life, all the fluids are in motion in each of the cells which compose the plant. Some cells take up the materials necessary for their growth or the formation of amylaceous, saccharine, and albuminous principles; other cells remove substances which have become useless and require to be eliminated, or matters which must be carried to other parts of the plant for cell-growth. This general movement constitutes the circulation. This name, however, is generally given to the more evident determinate currents which traverse the plant throughout its whole length.

The grand circulation consists, then, of an ascending and a descending current of sap. The ascent of sap takes place in the vessels which receive the liquids taken up by the roots from the soil. When the ascent commences, all the cells are in action. The nutritive substances which they contain are ready for assimilation. Starch, transformed into sugar by the action of diastase, is carried to those parts where it is required for cell-multiplication; the starch at the base of the buds goes to nourish them; that of the bark is conveyed into the interior of the cells of this organ. Under the influence of these nutritive matters increase in diameter commences by multiplication of cells. This cell-development at first takes place without the aid of the sap elaborated by the leaves, for we often find the cambium layers acquiring a considerable thickness before the leaves appear. The sap in ascending undergoes elaboration, and it contains certain matters fit for assimilation which may aid in the nutrition of the leaves and buds (in which the spiral vessels appear from below upwards).

The sap, after taking part in the nutrition of the first organs developed, reaches the leaves, where it is submitted to a new elaboration in their green parenchyma, as well as in the cellules of chlorophyll of the stems of fleshy plants without leaves. The carbonic acid of the air is absorbed, then decomposed during the day; its carbon is retained by the sap, and the greater part of its oxygen is evolved. The sap, modified under the influence of respiration, traverses the cortical cells, to which it imparts nourishment; it then contributes to the multiplication of cells of the generating layer, which increase in a horizontal direction. One part of the cells is multiplied horizontally, and forms a new layer of bark, ligneous fibres, and medullary rays; the others are transformed into vessels. The mode of formation of these vessels is as follows:—The excess of descending sap which is not used in the nourishment of the newly-formed cells, or in the thickening of those first formed, descends through certain of the newly-produced cells; it dilates them, perforates them, and makes them take all the characters of vessels.

This vascular formation takes place from above downwards, at the expense of the cells, which are multiplied in a horizontal series. This downward vascular formation has given rise to the idea that these fibres are the true roots of the buds or the leaves.

All the sap absorbed by the old and new cells, whether for their increase in length or thickness, or for the production of starch, albumen, and other matters required for after increase, is not used by the cells. A part only of its elements is assimilated, and the rest is thrown off. The latter, in the form of resin, essential oils, &c., is collected in particular reservoirs, whence it is poured out externally; or the non-assimilated matters are taken up by the laticiferous vessels, and are carried by them to the vessels properly so called (this is the venous circulation). There those substances which usually want oxygen are elaborated, oxidated under the influence of oxygen drawn from the air, and which reaches the vessels by the intercellular canals. Thus these matters become again fit for assimilation. From their oxidation results the carbonic acid given off during night, as well as that produced during the day, and decomposed in the leaves under the influence of light. The vessels formed by the descending sap serve during succeeding years for the ascent of the juices. They are filled with them so long as vegetation is very active, but are usually emptied by degrees as the fluids in the soil become less abundant.

M. Trécul has shown the course of the descending sap by means of ligatures round the stem, decortications, and other means. By such experiments sinuous vessels are produced; some parts of the vessels being vertical, others horizontal or oblique, according to the nature of the obstacles. These vessels are formed of cells elongated in a vertical direction—*i.e.*, parallel to the axis of the stem. The sinuosities of these vessels exhibit currents of sap moving through the cells of the generating layer, turning themselves in all directions in order to get an exit, perforating the cells from above downwards or horizontally, according as the current is vertical, oblique, or horizontal.

3. *Notice of a few plants collected in the vicinity of Glasgow in August* 1857. By Dr George Lawson.

Thursday, 13*th May*.—Dr Seller, President, in the Chair.

Dr Balfour exhibited a drawing of a branching coco-nut palm growing at Dunnock, St Ann's, Jamaica, the property of Dr Dakin. He also exhibited from Dr Coldstream a Chinese work on Surgery, compiled by Dr Hobson of Shanghai, containing woodcuts of some medicinal plants.

Dr Balfour also called attention to the elasticity of the stamens of *Thelygonum cynocrambe*. Flowering shoots of the plant, when dipped in water, and then allowed to dry, show in a remarkable manner the sudden protrusion of the filaments and the scattering of the pollen.

The following communications were read :—

1. *Short Biographical Sketch of Professor Gregory.* By Professor Balfour.

   (See page 172 of the present number of this Journal.

2. *Notes on the Action of the Soil on Vegetation.* By the late Professor Gregory; with a letter from Professor Alison. Communicated by Dr Balfour. (See page 166.)

3. *Reports of Recent Botanical Expeditions.*—(1.) Letter from Dr Hector, North America, to Dr Balfour. (See page 140 of this number of the Journal.) (2.) Letter from Dr W. Balfour Baikie, West Africa, to Dr Christison. (See page 138 of this number of the Journal.)

4. *On the Compound Nature of the Cormophyte.* By Alexander Dickson, Esq.

   (This paper appears in the present number of this Journal.)

SCIENTIFIC INTELLIGENCE.

BOTANY.

Tanghinia venerifera, or Cerbera Tanghin.—The seed of this plant is used in Madagascar as an ordeal poison. Kölliker and Pelikan have lately examined this poison, The effects are :—1. In about 5 to 15 minutes the heart was affected and stopped in its action; the ventricles became contracted and very small; whilst the auricles remained dilated, but were also paralysed. 2. The voluntary and reflex movements were at first not at all affected; but some time (half an hour to an hour) after the paralysis of the heart they became weaker and weaker, and gradually ceased totally, without any sign of spasms or tetanus. 3. The Tanghin poison has an influence on the voluntary muscles, which become paralysed. Lastly, the nerves are also paralysed. It is a paralysing, and above all a muscular poison, resembling *Upas Antiar.*

Qualities of Hieracium virosum.—" There are some poisonous species among the *Cichoriaceæ*. Among them may be mentioned the *Hieracium virosum*, Pall., which is often mistaken for *H. sabaudum*, and more especially the *Crepis lacera.* (Tenore, Flora Neap. ii., p. 179, tab. 79, et ejusdem Syn., p. 402. DC. Prod. vii. 161.)

" Tenore says of this Crepis, in his Synopsis, p. 403 :—' Venenatissima planta lacte maximè acri scabens; eademque, cum aliis sponte nascentibus Cichoreis, ad juscula conficienda lecta, sæpe illa comedentes miserrimè necavit.'

"Von Martens, in his 'Italien,' informs us respecting this plant:—'The *Angina* of the Neapolitans, called in the Abruzzi *Castellone*, constantly grows near calcareous rocks, and abundantly in the lower forest districts of the Apennines, from the Abruzzi to Calabria, especially on Gargano, where Micheli (Hortus Pisan., p. 81) represents it as an herb which kills pigs; also on the mountains of Caserta, Anienza, &c. The leaves resemble those of the dandelion, the chicory, and other species of the same family, which are much used by the country people as food; and as these plants are all used in spring before they flower, mistakes are easily committed, and poisoning with the Angina is consequently not uncommon. Gussone pointed it out to me on Mount St Angelo, above Castellamare, near Naples, at an elevation of 2500 feet, and mentioned an instance of poisoning of a whole family by it. The mother and children died in fearful tortures, and the husband alone recovered. On 21st July it was in full flower, and was then easily known by its tuft of gold-yellow flowers, and the mealy bloom which covered particularly the upper part of the plant, giving it a grayish-white appearance. When recognised in this state, the information is spread from mouth to mouth, so that the chicory gatherers may avoid in spring the places in which the Angina has been seen during the previous summer." (Schultz in Buchner's "Repertorium für Pharmacie," 1853, ii. 77, from "Bonplandia," i. 4.)

Persian Fruit.—Mr Murray sends specimen of a Persian fruit called *Senjed* or *Sendjed*. It bears some resemblance to the date. The tree grows vigorously on the slopes of the mountains near their base, and is generally found in greatest abundance on or near the banks of streams. In eating the fruit, which is neither very luscious nor high-flavoured, the outer skin is pulled off, in order to reach the pulp lying between it and the seed. It has an insipid sweet taste, and possesses astringent properties; so that it is used for the cure of diarrhœa. The flowers are pale yellowish. They expand in spring, and have a most delightful odour, which they retain when dry. The odour is said to possess aphrodisiac qualities. This is the current belief in the neighbourhood of Teheran.—*Communication from* Hon. CHARLES A. MURRAY, *Teheran, dated Dec.* 10, 1857.

CHEMISTRY.

Summary of Recent Views relative to the Action of the Soil on Vegetation (from the Notes of the late Professor GREGORY.)—1. Way, and after him, Liebig, have shown that every soil absorbs ammonia, and also potash, from solutions containing them or their salts, generally leaving the acid, which takes up lime, &c., from the soil, in solution. The ammonia and potash, which are absorbed in very large proportion by arable soils, are rendered thereby quite *insoluble*. 2. Arable soils absorb also silicic acid in very considerable proportion, and it also becomes insoluble. 3. Arable soils also absorb the phosphoric acid of phosphate of lime, or of ammoniaco-magnesian phosphate, apparently selecting the acid, which also becomes insoluble. 4. Hence the soluble ingredients of manures *cannot* be conveyed to the plants in the form of a solution percolating the soil (such as liquid manure, or a solution formed by rain-water with the aid of carbonic acid), since such a solution is deprived of its dissolved ingredients by filtering through a very moderate amount of soil. 5. Hence, also, as the food of plants must thus be fixed in the soil in an insoluble form, it is plain that it can only enter the plant in virtue of some power or agency in the roots, which decomposes the insoluble compounds in the soil, and thus renders soluble the necessary matter. 6. The absorbent power of soils is partly chemical and partly mechanical, as is the case with charcoal. 7. The quantity of alkalies, of phosphates, of ammonia, &c., capable of being supplied to plants by rain-water, after it has percolated through the soil, even supposing the whole to be assimilated, does not amount to more than *a mere fraction* of what the plants contain. 8. The theory of the transference of ammonia, potash, silica, phosphates, &c., from the soil to the plant is not yet understood; but the old theory, that the rain conveys food to the plant directly, is certainly not the true one.

GEOLOGY.

On the Geological Causes that have influenced the Scenery of Canada and the North-Eastern Provinces of the United States. By Professor ANDREW C. RAMSAY, F.R.S.—It is impossible thoroughly to explain all the points of this discourse without the aid of the pictorial illustrations and sections employed on the occasion, and therefore in this abstract only some of the leading geological features are noticed.

The island of Belleisle and the Laurentine chain of mountains between the shores of Labrador and Lake Superior consist of gneissic rocks older than the Huronian formation of Sir William Logan. This gneiss is probably the equivalent of the oldest gneiss of the Scandinavian chain, and of the north-west of Scotland, underlying that conglomerate, which, according to Sir Roderick Murchison, in Scotland represents the Cambrian strata of the Longmynd and of Wales. The mountains of the Laurentine chain present those rounded contours that evince great glacial abrasion; and among the forests north of the Ottawa the mammillated surfaces were observed by the speaker to be often grooved and striated, the striations running from north to south. The whole country has been moulded by ice. Above the metamorphic rocks, in the plains of Canada and the United States south of the St Lawrence, and around Lake Ontario and Lake Erie, the Silurian and Devonian strata lie nearly horizontally, but slightly inclined to the south. Consisting of alternations of limestone and softer strata, the rocks have been worn by denudation into a succession of terraces, the chief of these forming a great escarpment, part of which, by the river Niagara, overlooks Queenston and Lewiston, and capped by the Niagara limestone, extends from the neighbourhood of the Hudson to Lake Huron. Divided by this escarpment the plains of Canada bordering the lakes, and part of the United States, thus consist of two great plateaux, in the lower of which lies Lake Ontario—Lake Erie lying in a slight depression in the upper plain or table land, 329 feet above Lake Ontario. The lower plain consists mostly of Lower Silurian rocks, bounded on the north by the metamorphic hills of the Laurentine chain. The upper plain is chiefly formed of Upper Silurian and Devonian strata. East of the Hudson, the Lower Silurian rocks that form the lower plain of Canada become gradually much disturbed and metamorphosed, and at length, rising into bold hills trending north and south, form in the Green Mountains part of the chain that stretches from the southern extremity of the Appalachian Mountains to Gaspé, on the Gulf of St Lawrence. Between the plains of the lakes and this range the steep terraced mass of the Catskills, formed of Old Red Sandstone, lies above the Devonian rocks facing east and north in a grand escarpment.

The whole of America south of the lakes, as far as latitude 40°, is covered with glacial drift, consisting of sand, gravel, and clay, with boulders, many of which, during the submergence of the country, have been transported by ice several hundred miles from the Laurentine chain. Many of these are striated and scratched in a manner familiar to those conversant with glacial phenomena. When stripped of drift all the underlying rocks are evidently ice-smoothed and striated, the striations generally running more or less from north to south, indicating the direction of the ice-drift during the submergence of the country at the glacial period. The banks of the St Lawrence, near Brockville, and all the Thousand Islands, have been rounded and *moutonnée* by glacial abrasion during the drift period.

The submergence of the country was gradual, and the depth it attained is partly indicated in the east flank of the Catskill Mountains. This range, near Catskill, runs north and south, about 10 or 12 miles from the right bank of the Hudson. The undulating ground between the river and the mountains is seen to be covered with striations whereever the drift has been removed. These have a north and south direction; and ascending the mountains to Mountain House, the speaker observed that their flanks are marked by frequent grooves and glacial scratches, running not down hill, as they would do if they had been produced by glaciers, but north and south horizontally along the slopes, in a manner that might have been produced by bergs grating along the coast during submergence. These striations were observed to reach the height of 2850 feet above the sea. In the gorge, where the hotel stands at that height, they turn sharply round, trending nearly east and west; as if at a certain period of submergence the floating ice had been at liberty to pass across its ordinary course in a strait between two islands. During the greatest amount of submergence of the country, the glacial sea in the valley of the Hudson must have been between 3000 and 4000 feet deep, and it is probable that even the highest tops of the Catskills lay below the water.

In Wales, it has been shown that during the emergence of the country in the glacial epoch, the drift in some cases was ploughed out of the valleys by glaciers; but though the Catskill Mountains are equally high, in the valleys beyond the great eastern escarpment the drift still exists, which would not have been the case had glaciers filled these valleys during emergence in the way that took place in the Passes of Llanberis and Nant-Francon, and in parts of the Highlands of Scotland.

It has been stated above, that the upper plain around Lake Erie, and the lower plain of Lake Ontario, are alike covered with drift. Part of this was formed, and much of it modified during the emergence of the country. In the valley of the St Lawrence, near Montreal, about 100 feet above the river, there are beds of clay, containing Leda Portlandica, and called by Dr Dawson of Montreal, the *Leda clay.* Dr Dawson is of opinion that when this clay was formed, the sea in which it was deposited washed the base of the old coast-line that now makes the great escarpment at Queenston and Lewiston, overlooking the plains round Lake Ontario. It has long been an accepted belief that the Falls of Niagara commenced at the edge of this escarpment, and that the gorge has gradually been produced by the river wearing its way back for seven miles to the place of the present Falls.* In this case, the author conceives that *the Falls commenced during the deposition of the Leda clay, or near the close of the drift period,* when during the emergence of the country the escarpment had already risen partly above water. If it should ever prove possible to determine the actual rate of recession of the Falls, we shall thus have data by which to determine approximately the time that has elapsed since the close of the drift period; and an important step may be gained towards the actual estimate of a portion of geological time —*Royal Institution of Great Britain, April* 30, 1858.

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* The details on which this belief is founded may be found in the writings of Professor Hall of Albany, and Sir Charles Lyell.

ZOOLOGY.

Fresh-water Polyzoa.—Lieutenant Mitchell, at a meeting of the Madras Asiatic Society, observes, that Professor Allman, in his recent work, entitled, "A Monograph of the Fresh-water Polyzoa," has stated, that although found at an altitude of 6000 feet, these Infusoria had not yet been met with beyond the limits of the temperate zone. Now, Mr Mitchell has himself taken them in Madras, and gives a very interesting description of one he captured in considerable numbers adhering to the roots of the common duck-weed or Lemna in the month of September last. These, when placed in a polyp-trough, under a one-inch objective, exhibited groups of Polyzoa inhabiting tubular cells attached to the root of the plant and to each other. The head of the animal, which was transparent and hyaline, and furnished with a double row of cilia upwards of forty in number, was protruded from the cell in the act of feeding, and the whole process of capturing, swallowing, and digesting its prey, was distinctly visible. It seemed to prefer the smaller kind of Infusoria, rejecting the large Rotatoria, which were drawn into the vortex of the cilia by their rapid motion, an operation which it effected either by driving off the intruder by blows of the tentacula, or, if this failed, by retiring into the cell when the vibratile action of the cilia was suspended, and the unwelcome visitor escaped. Mr Mitchell believes that both this and other species will be found abundantly on the roots of Lemna and other fresh-water aquatic plants.

Nest of the Waxwing.—The waxwing makes a good-sized and substantial nest, but without much indication of advanced art. It is of some depth, and regularly shaped. The main substance of which it is built is the kind of lichen commonly called "tree-hair" (*Alectoria jubata*), which hangs so abundantly from almost every tree in Lapland. The nest is strengthened below by a platform of dead twigs, and higher up towards the interior by a greater or lesser amount of flowering stalks of grass, and occasionally pieces of equisetum. In one nest there were several pen-feathers of small birds as an apology for a lining. The nest is built on the branch of a tree, not near the bole, and rather standing up from the branch, like a fieldfare's or other thrush's nest. Of those observed, four were built on small spruces—one on a good-sized Scotch fir, and one on a birch, all at a height of from six to twelve feet from the ground.—JOHN WOLLEY, Junior.

Air in the Bones of Birds.—Mr E. Crisp, M.D., has lately published some interesting papers upon the air-sacs in birds, and the presence of air in the hollow bones. His investigations have led him to the following conclusions:—1*st*, That in the majority of British birds no air-cavities connected with the lungs are present in the bones. 2*d*, That the presence of air in the bones is not necessary for swift and long-continued flight, as instanced especially by the gulls, snipes, swallows, and martins. 3*d*, That in no bird examined by him was air found in the bones of the extremities beyond the *humeri* and *femora*.

Leopardus hernandesii, Gray.—A feline animal from Mazatlan has been described under the above name, which becomes very interesting from the fact of large animals of this family being comparatively few in the new world. "This species greatly resembles the jaguar in size, character, and marking, having the short legs and short tapering tail of that species; but it chiefly differs from that animal in the form of the head, which is more elongate, and in the disposition of the spots; instead of the spots being all placed in rings or roses, as they are usually called, the spots on the front part of the body are single and scattered, and those on the hinder part of the body are alone placed in rings and roses."—Dr J. E. GRAY.

MISCELLANEOUS.

The Solar Eclipse, as observed at Arbroath.—Throughout the forenoon of Monday, 15th March, the sun sometimes shone out, and at other times was obscured by clouds. The wind shifted from one point of the compass to another in rapid succession, and it seemed doubtful whether it would be possible to obtain even a glimpse of the sun during the period of the eclipse. About eleven o'clock the clouds assumed the cirrus form, and considerable portions of the sky in the region of the sun were altogether unclouded. The first contact of the moon's darkened hemisphere with the south-western border of the sun was distinctly seen at 45 minutes past 11; and at 24 minutes past 12 the margin of the lunar orb came in contact with the first and largest of a very beautiful cluster of spots which is now traversing the disc of the sun, and was then a little to the south of his centre. In seven minutes and a-half these spots were one after another hidden behind the moon, and it formed a very interesting spectacle to witness her approach to each several spot, which was seen as if for an instant it had attached itself to and formed part of the dark body of the moon. From the commencement to the middle of the eclipse a thermometer with a blackened bulb, exposed to the sun's rays, descended 14 degrees, the barometer also descended slightly during the eclipse, and at the time of its termination regained the same altitude as at the beginning. In the time referred to, the dry bulb thermometer in the shade only descended three degrees—the difference between the dry and wet bulb varying from four to five degrees. Five minutes before the time of greatest obscuration the sky became overcast, and the sun was no more seen for the day. The calm stillness and chill feeling at this time were very perceptible. A number of house sparrows were observed to manifest considerable uneasiness, such as they are wont to do previous to rain.

A very dark cloud in the south, about twenty degrees from the horizon, presented all the appearances of being fully charged with the electric fluid. In consequence of the increasing density of the clouds, no observation could be made as to the "beads and strings," as they are termed, which are usually seen in large solar eclipses. After the time of greatest obscuration, although the sun was invisible, the degree of light gradually increased and the chill feeling departed.

Every eclipse goes through a cycle of 12,492 years, one-tenth part of which is occupied in passing over the earth. In the case of the eclipse of 15th March 1858, the first time that the moon's penumbra touched the earth at the north pole was in the year 1299, after which it returned every eighteen years and ten days. The present is its thirty-first periodical return. When the eclipse shall have returned seventy-three times, it will finally leave the earth at the south pole in the summer of 2615. The last periodical return of this eclipse was on 4th March 1840, when the line of central eclipse passed over Asia, but in this country the eclipse was entirely invisible. The last time of its visibility in this country was on the afternoon of the 11th February 1804, and going backward still further, on the morning of the 8th January 1750. No return of the eclipse will be seen in this country until 17th April 1912, when it will again appear in circumstances little different in appearance from the phase of yesterday.

The following meteorological observations were made in connection with the observation of the eclipse:—

Time.	BAROMETER.	THERMOMETER.			Remarks.
	Reduced to 32° and sea level.	In shade.		In sun.	
		Dry bulb.	Wet bulb.	Black bulb.	
h. m.		°	°	°	
11 35	29·759	46	42	67	
11 45	...	...	...	...	First contact of Sun and Moon seen.
12 0	29·736	47	42	...	
15	...	45½	42	60	
24	...	...	...	64	First Solar Spot covered by the Moon.
31½	...	...	...	...	Last Solar spot covered by the Moon.
40	29·714	46	41	...	Wind veered from N.W. to W.
45	...	...	...	58	Calm.
55	...	46	41	...	Sun covered by clouds, and so continued for the day.
1 0	...	45	40	53	Greatest obscuration not seen; chill feeling.
20	...	44	41	...	Overcast.
40	...	44	40	...	
2 0	...	45	41	...	
2 15	29·762	45	42	...	

March 16, 1858. ALEX. BROWN, Arbroath.

OBITUARIES.

Obituary of Dr W. Gregory.—The University of Edinburgh has lost a distinguished member by the death of Dr WILLIAM GREGORY, Professor of Chemistry. He was the scion of a Scottish family which for many generations has been distinguished by great literary and scientific ability, and which has supplied eminent Professors to several of our Universities. In a direct line of descent, for nearly 200 years, the Gregories have been conspicuous in the scientific world. James Gregory, the well-known inventor of the reflecting telescope which bears his name, after distinguishing himself as a mathematician and physicist, was elected Professor of Mathematics in St Andrews in 1668, and afterwards was promoted to the corresponding chair in the University of Edinburgh. His son, the second James Gregory, was Professor of Medicine in King's College, Aberdeen, and was the least distinguished of the race. The succeeding generation revived the family honours—John Gregory, the son of the King's College Professor, having been one of the most distinguished British teachers of medicine in the middle of the eighteenth century. He filled the chairs of medicine in Aberdeen and Edinburgh, and was appointed first physician to His Majesty in Scotland in 1766. The next descendant of the family, James, the father of the subject of this notice, is better known to the present generation as having from 1790 to 1821 discharged with brilliant success the duties of the important chair of Practice of Physic in the University of Edinburgh; previous to which, however, he had for fourteen years been Professor of the Theory of Medicine. As a practitioner, a lecturer, and a scholar, Dr James Gregory was surpassed by none of his own time, and by few of any period in the history of medicine. Many are yet alive who have benefited by his professional skill; most of the surviving seniors of the medical profession delight to speak of the time when they sat on the benches of his lecture-room; and his *Conspectus Medicinæ Theoreticæ*—at once distinguished by the correctness of its views of the theoretical medicine of the day, and the purity of its style—is yet the admiration of those who can, and the terror of candidates for degrees and diplomas who cannot appreciate a most admirable specimen of elegant Latinity. Besides their scientific ancestry, the Gregories had a genealogy which must not be forgotten. They were a branch of the Clan Macgregor, and their name is a saxonification of the more emphatic Celtic patronymic. It is, we believe, a fact that Rob Roy formally acknowledged the alliance by paying a visit to his scientific clansman, at that time Professor in Aberdeen.

William Gregory was Professor James Gregory's fourth son. An elder brother, James Crawford Gregory, who died, was also educated for the medical profession. He embraced the practical department, but was cut off in the prime of manhood by typhus, contracted in the discharge of his duties as physician to the Royal Infirmary. William duly completed his medical studies, and graduated at Edinburgh in 1828; but for him practical medicine had no attractions. He very early showed a strong predilection for the study of chemistry, and, relinquishing all views of practice, he devoted himself to a science to which he has made some valuable additions. When but a young man, as the result of much and laborious experiments, he introduced a process for making the muriate of morphia, which, we believe, is still followed, and he thereby facilitated the introduction into practice of a very valuable remedy. Soon after completing his curriculum here, he went to the Continent for the purpose of prosecuting the study of chemistry, to which he had resolved to devote himself. After spending some time in the Continental schools, he returned to Edinburgh, where he established himself as an extra-academical lecturer on chemistry. He did not, however, continue long here. He was soon after appointed Lecturer on Chemistry in the Andersonian University of Glasgow, where he succeeded Mr Graham, the present Master of the Mint, who had been moved to University College, London, as successor to Dr Edward Turner. A favourable opening in Dublin having thereafter presented itself, he removed to the Irish capital, and lectured in one of the medical schools there. In 1839 he was appointed to the Professorship of Medicine and Chemistry in King's College, Aberdeen, and thus became the occupant of a chair which had been filled by more than one of his distinguished ancestors. In 1844 he was elected by the Town Council to the Chair of Chemistry in the University of Edinburgh, on the death of Dr Hope. His chief opponent was Dr Fyfe, the present distinguished Professor of Chemistry in King's College, Aberdeen.

At the time of Dr Gregory's graduation in 1828, but when he had already made up his mind to aim at distinction only as a chemist and teacher of chemistry, the greater part of what we now regard as the first principles of this science had been brought to light within the recollection of the passing generation. This may be said of the system of Lavoisier, of Priestley, and Cavendish, founded on the experiments which determined the constitution of air and of water, and the nature of combustion; of the researches of Black and of Watt on the nature of carbonic acid and the properties of steam; of the laws of crystallography, ascertained by Haüy; of the atomic theory, originating with Dalton; of the analysis of the alkalies, and discovery of the nature of chlorine, by Davy; and of all the applications of chemistry to illustrate the processes of assimilation, nutrition, respiration, and excretion, both in vegetables and animals; and likewise of the application of these processes to illustrate the results of examination of the memorials of the former inhabitants of the globe made known to us by geology. In order to bring within a reasonable compass the instruction to be given on subjects of such extent and interest, Dr Gregory early saw the necessity of a greater subdivision of the science than had previously been adopted; and in the preface to his "Outlines of Chemistry," published in 1845, he assigned his reasons for the division of the *ponderables* from the imponderables, and the exclusion of the former elementary subjects,—*i.e.*, of heat, light, electricity, and magnetism, from the study of the *ponderables*, or proper chemical elements, whether solid, fluid, or gaseous, and their compounds; and if his health had enabled him to execute what at one time he had in view, a separate and complete course of lectures on each of these, the whole of the instruction delivered from that chair would probably have been more complete than from any other scientific chair in Europe. But when the subject of chemistry is nearly confined to the ponderable elements, the study of the imponderables must be held as preliminary to that subject, and as being usually made part of natural philosophy and part also of natural history. On the other hand, several of the applications of chemical science to the arts are of late years provided for in our University, by the professorships of agriculture and of technology.

The departments of chemical science which Dr Gregory regarded as chiefly demanding attention from him, both on account of their novelty and their importance in all departments of medicine, were those which concern the *organic* as distinguished from *inorganic* substances. To the former subjects, as appears by his volume of Outlines, not less than two-thirds of his course of lectures were appropriated; and as he was early convinced that the chief progress in the truly scientific treatment of these subjects is at present on the continent of Europe, he soon attached himself particularly to the celebrated Professor Liebig of Giessen, whom he assisted in several of his courses of experiments, and several of whose publications, at the request of their author, he translated and edited in this country. The last and best known of these are "Familiar Letters on Chemistry, and its applications," of which the third edition was published in 1851; and in regard to his execution of that task, it is sufficient to quote the words of the illustrious author:—"From his intimate familiarity with chemical science, and especially with the physiological subjects here treated, I am confident that the task could not have been entrusted to better hands than those of my friend Dr Gregory." It is satisfactory to add, that the friendly intercourse of these men of science continued unabated to the last, and that the last scientific labour executed by Dr Gregory was a short paper stating his belief in the truth and importance of certain views of which he had received an account a few weeks only before his death from his friends. With Baron Liebig he was also joint editor of posthumous editions of Dr Edward Turner's "Elements of Chemistry."

When suffering of late years from repeated attacks of painful disease, he found it absolutely necessary to relax somewhat from the harassing labours of his lectures and practical instructions. He sought relief at times by change of scene, and at times only by a change of the subjects of study, particularly by the use of the microscope.

Dr Gregory retained throughout life the same simplicity and earnestness of character which had distinguished him as a zealous and devoted student of natural science. Incapable of deceit himself, he was unwilling to ascribe any such intention to those from whom he received what they held out as scientific facts; and hence, in the opinion of many of his friends, he was too credulous as to the evidence of certain alleged principles of science. His knowledge of the modern languages was such as to enable him to enjoy the society of several scientific friends both in Germany and France, and he often enjoyed better health in those countries than in this; but his naturally candid and benevolent disposition attached him strongly to his native city and his friends in Scotland. Under much and varied suffering from disease, he was uniformly and remarkably patient and cheerful.

As a scientific man, Dr William Gregory worked more for utility as a teacher than for fame as a discoverer. His principal memoirs were on Pyroxanthine, a solid volatile product of the destructive distillation of wood; on a Compound of Sulphur and Nitrogen; and on the Decomposition Products of Uric Acid; whilst to practical chemistry he contributed improved processes for the preparation of hydrochloric acid, oxide of silver, and muriate of morphia. He is better known, however, for his writings than for his laboratory work. He had a thorough knowledge of all that had been done, and that is not little, in chemistry up to the present time; and none was better able than he to give information to any inquiring student as to the actual state of our knowledge on any chemical subject, especially in the interesting and pre-eminently important department of organic chemistry. This knowledge he embodied in an elementary work, which, in a succinct form, presents the best *résume* of chemistry, especially in the organic department, which exists in the English language.

On this subject he made several valuable communications to the Society, illustrated by magnified drawings, beautifully executed, by Dr Greville, who aided him in these researches. The last volume of the Transactions of the Royal Society of Edinburgh contains an elaborate and beautifully illustrated memoir by him on this subject. He has left behind him some further researches on this curious subject, which it is hoped will be published under the superintendence of Dr Greville. M. de Brebisson, in alluding to Dr Gregory's papers on Diatomaceæ says,—"ses travaux sont des plus grands prix pour la science." The late M. Bailey of New York also says,—"I have read Dr Gregory's papers, as they appeared in the "Microscopical Journal" with great interest; and I believe that he is working in the right direction. I am a complete sceptic as to the value of any of the characters now relied on for the specific or even generic characters of the *Diatomes*. Form, number, size, colour, &c., all fail."

From an examination of Dr Gregory's manuscripts, there is abundant evidence to prove, that his minute and patient observation was wonderful:—"Whether he was right or not in some of his views of specific difference, they were not arrived at by hasty examination. Some people who find, perhaps, only one or two examples of one of his species in a slide, would be ready to jump to the conclusion that he was content to decide upon too scanty materials. But in such cases he persevered through hundreds of slides,—often mounted only to be subsequently destroyed,—until he had completed his investigation. He kept a record of everything of interest in every slide he examined, and the amount of labour is perfectly astonishing.

Notwithstanding his occupation with these inquiries in another field, he continued to be a diligent student of his own science, and kept himself faithfully *au courant du jour* as to what was going on in the chemical world. As a teacher and writer he has been highly useful in his day and generation; and for this, as well as for his amiable disposition, his memory will be cherished and respected.

Dr Gregory died in his fifty-fourth year. He leaves behind him a widow and only son (named after his friend Liebig), to mourn his premature decease.—(*From notices in Edinburgh Newspapers and other sources.*)

Obituary of Dr John Forbes Royle.—Science has sustained a loss in the death of Dr Royle, which took place at his residence, Heathfield Lodge, Acton, Middlesex, on the 2d of January 1858. He had been for many weeks in ill health, but his death was sudden at last. Dr Royle was educated in London for the medical profession, and was a pupil of the late Dr Anthony Todd Thomson, from whom he seems to have acquired that taste for the study of botany which afterwards distinguished him. Having passed his medical examinations, he entered into the service of the East India Company, and was for many years stationed in the Himalaya, where he had great opportunities afforded him of studying, not only the plants of that district, but of the whole empire. He was appointed superintendent of the East India Company's Botanic Garden at Saharunpore,—a position which gave him the largest possible opportunity for studying the indigenous Flora of Hindustan. The result of his labours was given to the world in a magnificent work, entitled, "Illustrations of the Botany and other branches of Natural History of the Himalayan Mountains, and of the Flora of Cashmere." This work was published in folio, with plates, in 1833, and at once gave to the author a European reputation as a botanist. In this work Dr Royle gave the result of his researches into the medical properties of a large number of plants, as well as the history of drugs used in Europe, whose origin was unknown. In 1857, he published an essay "On the Antiquity of Hindu Medicine," a work displaying much learning and research. On the opening of King's College, London, as a medical school, the knowledge of drugs and plants possessed by Dr Royle pointed him out as a fit person to hold the Chair of Materia Medica, a position which he filled till the year 1856. Whilst lecturing on this subject, he published his "Manual of Materia Medica," a book which is now used as a text-book on the subject in medical schools. His extensive knowledge of the natural history of India made him a valuable contributor to the periodical scientific literature, and he was a contributor to "The Penny Cyclopædia," and Kitto's "Dictionary of the Bible," and other works. He took an active interest in promoting a knowledge of the material resources of India, and in 1840 produced a work which perhaps will be read with more interest now than when it was published, "On the Productive Resources of India." During the period of the Russian war, Dr Royle drew attention to India as a source of the various fibrous materials used in the manufacture of cordage, clothing, paper, &c., by a lecture delivered before the Society of Arts in 1854. This lecture was afterwards expanded into a valuable work "On the Fibrous Plants of India," which was published in 1855. In the preface to this work he announced that he was employed in a general work on "The Commercial Products of India," which, however, has not yet appeared. Dr Royle was a member of the British Association for the Advancement of Science, at whose meetings he often read papers, two of which deserve especial mention, one "On the Cultivation of Cotton," and another "On the Cultivation of Tea in the East Indies." He took an active interest in the last subject, and his efforts have been attended with complete success, as tea, rivalling that from China, is now produced in abundance in the Himalaya. For a short time he held the office of Secretary to the British Association for the Advancement of Science. He took an active interest in the development of the plan of the great exhibition of 1851, and the success which attended the exhibition of the department of Indian Products was due in a great measure to his efforts. He was a Fellow of the Royal, Linnean, and Geological Societies, and at the time of his death held an appointment in connection with the East India Company in London. A subscription is on foot to get a bust of Royle placed in the hall of King's College, London.—*Athenæum.*

Robert Brown, botanicorum facile princeps.—An obituary of this eminent botanist, who died on 10th June 1858, is unavoidably postponed until next number of the Journal.

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On the Skeleton, Muscles, and Viscera of Malapterurus Beninensis. By JOHN CLELAND, M.D., Demonstrator of Anatomy in the University of Edinburgh.*

The anatomy of the electric apparatus and nervous system of *Malapterurus electricus* has been already beautifully elucidated by Dr Bilharz of Cairo.† The results of his investigations can only be expected to be verified with newly-killed specimens at command, and such an opportunity has yet been lacking; but as the genus Malapterurus is a remarkable one, and belongs to an interesting group, and since the species from the west coast of Africa has been only recently distinguished by Mr Murray from that inhabiting the Nile, I have, meantime, under the auspices of Professor Goodsir, undertaken an account of the skeleton, muscles, and viscera of the former. I shall notice the differences between it and *Malapterurus electricus*, as far as Dr Bilharz's book affords material for comparison. I am indebted to Professor Goodsir and Mr Murray for specimens.

Skeleton.

The skeleton of Malapterurus, like that of other Siluridæ, is remarkable for the flattened shape of the head, and the tendency to coalescence of the facial bones.

* Communicated to the Royal Physical Society, 23d December 1857.

† Das Electrische organ des Zitterwelses anatomisch beschrieben von Dr Theodor Bilharz, Professor der Anatomie in Kairo, Leipzig, 1857.

The *cranium* may be divided, for purposes of description, into two parts—the cerebral and the nasal. The former portion is, in this species, somewhat of a square form, but tapers a little to the front; the other part is much narrower and longer than the first. Looked at from above, it has this peculiarity, —viz., that the *parietal* bones are absent. The *supra-occipital* bone is well developed; it has no dorsal crest. It articulates broadly with the great frontal bone in front, and laterally with the mastoid and ex-occipital. The *ex-occipital* bone presents a foramen for the great lateral nerve, and a process with which the scapula is articulated. The *mastoid* bones complete the posterior margin of the skull, and form the larger part of the lateral margins of the cerebral part. Each presents three processes, the two posterior of which are connected with a Y-shaped cartilaginous representative of a supra-temporal set of bones, and the anterior with a bone which joins the infra-orbital range. The *post-frontal* bone completes the lateral margin, and combines with the great frontal to form the anterior margin of the cerebral part of the cranium. It presents a long process, which projects laterally from the skull, and to which the sub-orbital chain of bones is articulated. The *great frontal* bone is broad behind, where it enters into the formation of the cerebral part of the cranium, narrow and bifurcated in front, where it forms part of the roof and sides of the nasal portion. By its bifurcation it forms the posterior and lateral walls of a long opening, which is completed anteriorly by the nasal and pre-frontal bones. The great frontal bone articulates with the supra-occipital, mastoid, and post-frontal bones posteriorly, with the orbito-sphenoid bones and inter-orbital plate, placed laterally and beneath it, and anteriorly with the pre-frontal and nasal bones.

Turning to the under surface of the skull, we observe that there is no *petrosal* bone. The *basi-occipital* bone underlies at its posterior extremity the thin body of the first vertebra. It has a slight process on each side, from which springs a short ligament by which the scapula is attached. The *par-occipital* bone enters considerably into the formation of the base of the skull, and presents three foramina for branchial nerves. It articulates with the basi-occipital, ex-occipital, mastoid, and ali-sphenoid bones. On its cranial aspect, close upon the basi-occipital bone, lies a flat and almost circular otolith, like the one in *Silurus glanis* (Weber). The *basi-sphenoid* bone articulates by a scaly piece with the basi-occipital, and in front of this widens somewhat, and articulates with the ali-sphenoids, it then becomes narrow and elongated, and enters into the formation of the nasal part of the skull, and is connected with the orbito-sphenoids, one on each side, and in front of them with the inter-orbital plate, whose flat under surface rests upon it, and anteriorly with the vomer. The *ali-sphenoid* bone articulates with the par-occipital, mastoid, post-frontal, orbito-sphenoid, and basi-sphenoid bones, and presents a large notch anteriorly, which is completed by the post-frontal and orbito-sphenoid into a large foramen for the exit of the third, fourth, fifth, and sixth nerves. The *orbito-sphenoid* bone presents on its under surface posteriorly a foramen for the optic nerve; and the spiculum of bone which separates this from the above-mentioned larger foramen behind it is prolonged into a stiletto-like process, projecting laterally, and passing between the optic and fifth nerves. In front of the orbito-sphenoid bones is the completely ossified *inter-orbital plate*, broad and squamous in form, and resting on the basi-sphenoid bone, beyond which it projects as a horizontal lamina on each side, and aids the partition of the orbital from the oral cavity. From its upper surface two laminæ ascend to articulate with the great frontal bone, and with it complete a segment of the skull. It articulates in front with the pre-frontal bones. The *pre-frontals* are fused into one, and form a complete tube, continuous with the segment just mentioned, but divided into two by a vertical mesial septum, and closed in front so as to leave only two foramina for the exit of the olfactory nerves. The upper surface has a double groove for the nasal bone, and is notched posteriorly where it enters into the anterior wall of the opening. At the anterior lateral angle is a smooth surface for articulation with the palate-bone, and the posterior part of the lateral margin is in contact with the pterygoid bone. Its under surface is prominent in the middle line, where it is in contact with the vomer. The vomer is squamous, without teeth, and articulates behind with the basi-sphenoid, and in front with the nasal bone. The under surface of the *nasal* bone passes on in the same horizontal line as the vomer, and terminates in two broad lobes some distance in front of the pre-frontal. Superiorly it expands backwards on the pre-frontal bone, and articulates with the great frontal on each side of the opening.

In the Nilotic species of Malapterurus, as represented by Bilharz, the nasal portion of the cranium is much narrower than in *M. Beninensis,* and the opening is reduced to a narrow fissure. The cerebral portion also is much more compressed from before backwards, the supra-occipital bone being much less expanded.

Face Bones.—The *intermaxillary* bones are united by a symphysis which allows of some motion, and each is articulated a little way from its inner extremity to one of the lobes of the nasal bone, without interposition of a cartilage. By this arrangement, although in their natural position they lie in one horizontal plane, they form a decided arch when the mouth is open. They pass outwards and backwards, and their outer extremities are united by ligaments to the hypo-tympanic bones. They are covered with velvety teeth. The *superior maxilla* is feebly developed, and does not reach more than half way to the inferior maxilla. It is attached by fibrous tissue to the nasal bone behind the lobe, and by joint to the anterior extremity of the palate bone. The *palate* bone is small and linear, and passes outwards and backwards to articulate by a facet on its inner aspect with the pre-frontal, and by ligament with the pterygoid bone. The *pterygo-tympanic* series of bones are so closely united as to appear like one bone, and are pulled asunder with some difficulty. They lie in a plane approaching the horizontal. The individual pieces are only four in number,—viz., the epi-tympanic bone, articulating with the skull and with the operculum; the sympletic, thick and irregular in shape, and with hollows for mucous tubules; the hypo-tympanic, articulating inferiorly with the inferior maxilla, and connected by ligament with the intermaxillary bone; and lastly, the pterygoid, which articulates with the pre-frontal and the palate bone. The *inferior maxilla* consists of only two pieces at each side, the articular and the dental; the last is armed with velvety teeth.

The *operculum* consists of two pieces, massive in structure,—the opercular bone, articulated by a complete joint to the epi-tympanic bone; and the inter-opercular bone, of a triangular shape, with its base attached by ligament to the anterior margin of the opercular bone, and its apex to the articular bone of the lower jaw.

The *infra-orbital* bones are six in number on each side. They are hollow tubes, in which mucus glands take their rise. Five of them form a chain from the process of the post-frontal bone to the side of the nasal bone, and the sixth passes from the posterior extremity of this chain to the anterior process of the mastoid.

The *supra-temporal* bones, as already stated, are represented by a cartilage arising from the mastoid bone by two origins, which unite so as to form a Y-shaped structure, which terminates in the integument at the upper extremity of the branchial aperture.

A similar cartilage, of a linear shape, arises a little farther back from the upper part of the coracoid bone, and also passes outwards to support the integument of the branchial aperture—this being one of the Siluridæ which have the branchial aperture narrow, and the skin hanging so loosely round it that the branchiostegal rays are invisible beneath it. Probably this last cartilage represents the *clavicle*, that bone being otherwise absent.

The *hyoid* arch consists of four pairs of bones. The superior bone (the stylohyal) is reduced to a mere nodule like the smallest pin-head. The remaining three are beautifully united. The ceratohyal is a hollow cylinder, open at both ends, and the epihyal and basihyal are hollow caps, which are united to it by suture so as to form one bone, consisting of a shaft and two epiphyses. The basihyal bone is separated from its fellow by the apex of the urohyal,—a triangular bone with the apex in front and the base behind, lying in the horizontal plane. The hyoid arch is suspended by two ligaments, one passing from the stylohyal to the epi-tympanic bone, and another from the epihyal to the articular piece of the lower jaw. The glossohyal bone is slender and linear, with a slight prominence at the attachment of each of the four branchial arches; it was mere cartilage in the specimens examined. The superior *pharyngeal* bones are circular, the inferior elongated and triangular, and both pairs toothed like files.

Anterior Extremity.—Only five bones, besides the fin rays, enter into the skeleton of the anterior extremity. The *suprascapula* and *scapula* are replaced by one bone. This bone fits into the notch between the projecting ex-occipital and mastoid bones, and stretching horizontally outwards, it expands and bifurcates, forming a notch into which the coracoid bone fits. From its under surface a long process shoots downwards and inwards towards the basi-occipital bone, its course to which is completed by a short ligament. The *coracoid* bone completes the arch of the shoulder girdle. One of its margins is convex and directed forwards and outwards, and is somewhat flattened where it forms the posterior wall of the branchial fissure. About one-third from its upper extremity the bone becomes abruptly narrow, as if a piece had been cut out of the concave margin which looks backwards and inwards. Its breadth is supplemented by a bone which fits so closely on to it as to seem a part of the same, and whose posterior margin is continuous with the upper part of the posterior margin of the coracoid. It lies on the outer surface of the coracoid bone, and, widening as it descends, articulates broadly with its fellow of the opposite side. The outer surface of the coracoid bone, above the supplementary bone, is in contact with a cul-de-sac of the peritoneal cavity, which contains a lobe of liver. This circumstance, as well as the muscles directed forwards taking origin from the inner surface of the shoulder girdle, shows that the convex margin of the coracoid corresponds to that which in most fishes looks backward and outwards. The supplementary bone consists apparently of the *radius* and *ulna* combined. It presents two large processes toward its upper end: one is vertical, and gives attachment to the outer part of the pectoralis muscle; the other is transverse, and perforated by a foramen, and at its anterior extremity gives attachment to the carpal bones.

The *carpal* bones are only two in number; they are small and linear, and support the posterior two or three of the eight fin rays. The anterior rays are attach ed to the coracoid bone, in a straight line with the transverse ridge which supports the carpal bones. The fin, when in action, lies in the horizontal plane at right angles to the body of the animal; and the support given to the posterior rays by the carpal bones compensates for the slope inwards and backwards of th shoulder girdle. When at rest, the fish can make the fin li alongside of its body by flexion downwards and forwards of the carpal bones, which carry with them the most posterior fin rays, and, with the attachment of the most anterior rays for a fixed point, turn the fin round into the vertical plane.

Vertebral Column.—Immediately behind the cranium are a series of altered vertebræ, to be considered anon. They are very similar in both species, and are reckoned by Dr Bilharz as three in number. They are, however, four vertebræ, as I shall show. Counting them as four, there will then be, according to Dr Bilharz, twenty vertebræ of the trunk, and twenty-two caudal in the Nilotic species. The species which we are considering has only nineteen trunk and twenty-one caudal vertebræ. The superior spinous processes of the caudal vertebræ are long and pointed, as are also the inferior spines; but those of the trunk get gradually shorter and thicker as we pass forward,in such a manner that the tips of these processes lie in a pretty straight line from the occiput to the tip of the tail. Every vertebræ, those next the head excepted, presents on each side a posterior articular process, projecting upwards from the posterior part of the body, and a deep notch between this and the neural arch for the exit of the corresponding nerve; also an anterior articular process articulating with the posterior articular process of the vertebra in front, and with its neurapophysis. The spines of the last caudal vertebra are united and expanded into a single broad triangular plate, and the inferior spine of the vertebra in front is likewise flattened. The caudal fin rays are eighteen in number. The pelvic bones are slender immediately in front of the vent, and in the specimens I have seen are connected with one another by an unossified portion. Each ends anteriorly in two processes projecting forwards. There are six abdominal fin rays. From the pelvis on each side passes outwards a ligament dividing into three parts, which are lost in the aponeurotic sheath of the great lateral muscle. Bilharz pictures it in the Nilotic species.

Modified Vertebræ.—The first vertebra is very small. Its body is narrow, and the basi-occipital bone is prolonged under it. The neurapophyses are separate little linear bones unconnected with the body, and imbedded in fibrous membrane immediately behind the occiput. The first vertebra has no neural spine in this species, although in the Nilotic species its neural spine is a distinct bone, as Dr Bilharz shows. Dr Bilharz mentions another pair of small bones in connection with the first vertebra; but there is good reason to believe that they are only part of the stapes bones, described below.

The second, third, and fourth vertebræ are peculiarly modified, and almost inseparably united; that is to say, in one small specimen I succeeded in pulling the third and fourth separate, but it is impossible to separate the second and third. Dr Bilharz describes the second and third as one vertebra, but they are certainly two. On the visceral surface, the combined body of the three vertebræ exhibits distinctly the junction of the third and fourth by a deep toothed suture, and indications of the still more thorough union of the second and third. It presents in the middle line a large foramen, the opening of a short canal which bifurcates in the substance of the bone, and opens on each side under the posterior margin of the transverse process of the second vertebra. The branchial veins enter this Y-shaped canal, one at each side, and unite in it to form the aorta. The transverse processes of these vertebræ arise from the neural arch. The neural arches of the second and third vertebræ are fused in one continuous lamina, without neural spine, and with a notch in front that fits to a projection of the supra-occipital bone; but at each side a triangular space is left, the anterior part of which is occupied by the little bones in connection with the first vertebra, while from behind them issue the electric and other nerves. The transverse process of the second vertebra is greatly developed. It lies horizontally at its origin, but as it passes outwards it alters its plane, and describes a curve, with the convexity forwards, and its anterior margin turned downwards. It is adapted to the anterior extremity of the swimming bladder, and is connected by a ligament with the ex-occipital bone. Bilharz considers it as a part superadded to the second vertebra, and calls it by the name given to it by Müller, the spring process (springfederfortsatz), and describes as the transverse process that of the third. From the dorsal surface of the spring process a cylindrical secondary process, the stem process of Bilharz, pass inwards; and its inner extremity is so nearly in contact with the neural arch that it presses against it when the spring process is pressed upwards.

Professor Müller was the first to mention the spring process, and its connection with the swimming-bladder, both in Malapterurus and other fishes.* A strong slip of the dorsal muscle connects the anterior surface of the process with the occiput; and by its contraction Müller considers that the process is drawn forwards, and that so the air in the swimming-bladder is rarified; and that, when the contraction ceases, the process springs back into its place by its elasticity. The stem process, by abutting against the neural arch, will prevent too great a displacement of the spring process.

Immediately behind the transverse process of the second vertebra lies that of the third, shorter and broad, lying in the horizontal plane, so that the swimming-bladder, in expanding, will press it upwards. The transverse process of the fourth vertebra is a simple stiliform process, rather shorter than that of the third. Its neural arch is prolonged into a rudimentary spine, and a round foramen, closed by a membrane, is left between it and the neural arch in front. In *M. electricus*, Bilharz represents this foramen as nearly completed by the latter arch, and a separate bone fitted into the remaining interval, and overlying the two following spines. This bone he calls the spine of the second vertebra. It does not exist in the species before us. On removal of one side of the neural arch of the conjoined vertebræ, the upper surface of the body is seen to be divided by two transverse elevations into three equal parts of the same length as the bodies of the other vertebræ, and the third and fourth are not more distinctly separated than the second and third. Moreover, there are seen three pairs of foramina for nerves, the first passing out above the spring process, the second above the transverse process of the third vertebra, and the third close to the posterior margin of the fourth vertebra. These circumstances leave no room to doubt that we have really to do with three vertebræ united together. The transverse processes of the fifth and sixth vertebræ arise from the junction of the neural arch and body; those behind arise from the sides of the bodies, each pair on a lower level than the pair in front.

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* Müller's "Archiv," 1842, p. 319. He states that the Silurians in which he has observed this apparatus have a narrow branchial fissure,—viz., the genera Auchenipterus, Synodontis, Doras, Malapterurus, and Euanimus.

In connection with the three first vertebræ are three pairs of little bones, or processes, of the description called Weber's apparatus. The bone belonging to the first vertebra—the stapes—is situated behind and below its neurapophysis. It consists of a linear portion, similar in size and shape to the neurapophysis, and of another portion, oval and hollowed on the inner aspect, and lying at right angles to the lower extremity of the first portion, directed forwards. Bilharz, as above mentioned, describes the linear part as a separate bone, but since he represents them united, in his sketch of the separate bones; and since the stapes of *Silurus glanis* represented by Weber* is exactly the same shape as that of Malapterurus, if we include the linear part; and since, in the species before us, I can see no symptom of the portions being separable; I am inclined to think that Bilharz must be mistaken in describing them as distinct bones. The bone in connection with the second vertebra—the malleus—is considerably larger. It lies along the side of the body of the vertebra, and is straight anteriorly, but curved downwards and inwards posteriorly over the lateral foramen in the body of the vertebra. At its centre it is attached by a very slender thread of bone to the upper part of the body of the vertebra, so as to admit of considerable motion. In the *Silurus glanis* there is a small bone unconnected with any vertebra, viz., the incus, joining the stapes and malleus (Weber), but there is no vestige of it in Malapterurus. But from the under aspect of the transverse process of the third vertebra a long and slender spiculum passes inwards and forwards between the malleus and the body of the vertebra, and expands into a little plate the size of a pin-head, which lies over the lateral foramen. When the malleus is pressed upon, as it would be by the distended swimming-bladder, its curved extremity presses this little plate down upon the foramen, and its anterior extremity comes in contact with the stapes and presses it inwards. This curious little process, if it exists in the Nilotic Malapterurus (which one would be disposed to think it did, from the close similarity of the neighbouring parts), has escaped the eye of Dr Bilharz ; neither does it appear from Weber's account that we have anything of the sort in *Silurus glanis.* As to the function of the little bones in *Silurus glanis,* of which two, the malleus and stapes, are very similar to those in this fish, Weber writes as follows :—" When the superior part of the swimming-bladder is expanded, the malleus is pressed upon the incus, the incus on the stapes, and the stapes on the atrium of the sinus impar, whose water, being propelled into the sinus impar and vestibule, expands and distends the membranous labyrinth. The upper part of the bladder being relaxed, the malleus, by the elasticity of the processus folianus, returns to its old position, and the whole labyrinth is relaxed. Moreover, tremors of the swimming-bladder itself are no doubt transferred to the labyrinth by the ossicula.*"

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* Weber, De aure et auditu.

On the same principle is the arrangement in the fish that we are considering. When the fish descends in the water the ossicula are pressed on, and the labyrinth distended ; and thus a pressure from within is furnished to counterbalance the increased pressure from without. At the same time, the little processes of the third vertebra will be pressed upon the branchial veins, and must more or less impede the circulation in the head and gills ; so that they would appear to modify the pressure of blood on the head according to the pressure of water upon the fish.

Muscular System.

The muscles of *mastication* of the Malapterurus are remarkable in their relation to the eye. By much the largest mass arises from the whole roof of the skull, as far forwards as the anterior extremity of the great frontal bone, and passes over the optic nerve and muscles of the eye in its course to the articular piece of the lower jaw, into the upper angle of which it is inserted. The eye-ball is situate at its external border. Another mass arises from the upper surface of the tympanic bones, and is inserted along with the preceding; it is smaller, and lies below the eye. Another and slender muscle is attached anteriorly to a process on the superior maxilla, and behind, to the epi-tympanic bone. Thus the structures to the eye-ball, as well as the divisions of the fifth nerve, pursue their course between two great masses of masseter muscle.

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* Weber, op. cit., p. 57.

The *transversalis palati* muscle arises from the under surface of the basi-sphenoid and anterior frontal bones and the inter-orbital septum, and its fibres pass transversely outwards to the under surface of the pterygo-tympanic arch. The *mylohyoid* arises from the upper half of the hyoid arch, and is inserted in the whole length of the dental piece of the lower jaw. A muscle arises from the posterior border of the hyoid arch and from the inferior branchiostegal rays, and its fibres, passing transversely inwards, are inserted in the middle line on the under surface of the *urohyal bone*, which it is calculated to *elevate*, and it must therefore act as a muscle of deglutition. The so-called *sternohyoid* muscle passes from the posterior border of the urohyal bone backwards to the coracoid bone, and lies near its fellow of the opposite side.

The *muscles of the operculum* are three: one arises from the orbito-sphenoid and anterior part of the post-frontal bone, and, passing beneath the long process of the post-frontal, receives additional fibres from the lateral margin of that bone, and is inserted into the superior angle of the operculum, and acts as a levator. Another arises from the side of the mastoid bone, and is inserted into the upper part of the posterior margin of the operculum, and acts principally as a depressor; and another depressor arises from the posterior margin of the tympanic arch, and is inserted on the under surface of the operculum.

Two muscles pass from the *cranium to the shoulder girdle* to pull it forward. One arises from the under surface of the mastoid bone, and is inserted into the inferior process of the scapula; the other arises immediately outside the former, and is inserted into the upper part of the coracoid bone.

Small muscles attach the branchial arches to the base of the skull. A ligament passes from the superior junction of the two posterior branchial arches to the coracoid bone, and another from the junction of the two anterior arches to the epi-tympanic bone.

Muscles of the Body.—The *recti abdominis* muscles, touching each other in the middle line, extend from the shoulder girdle to the pelvis, and, behind the pelvis, are again continued by two slips which pass from the deep surface of the pelvic bones to the first interspinous bone of the anal fin. External to the rectus, a separate slip of the great lateral muscle passes uninterruptedly from shoulder to tail, and it is at its outer margin that the electric vessels and nerve emerge. It is overlaid behind by the superficial muscles of the anal fin. Separate slips also pass along the dorsum from head to tail, and between them and the main mass is the position of the great lateral branch of the vagus. But what is most worthy of notice is, that the greater number of muscular fibres arising from the coracoid and radio-ulnar bones form a pectoral muscle, superficial to the other fibres of the great lateral, and digitating with them along the side of the fish opposite the extremities of the fifth, sixth, seventh, and eighth ribs. It is an interesting illustration of the transition from the primitive arrangement in flakes to the formation of distinctly-defined muscles. A strong fasciculus, springing from the occiput, is inserted into the anterior aspect of the spring process; and this is the muscle to which Müller has directed attention, and to which reference is made in a previous place.

Viscera.—The throat and stomach are large and wide; so much so, that I found two large shrimps, which had been swallowed whole, in the stomach of a specimen four inches long. On examining the remains of a number of putrid specimens, I found that they had been feeding entirely on Crustacea. The stomach is about one-third the length of the abdominal cavity. There are no pancreatic cœca; but from the pylorus, which is situated side by side with the œsophageal opening of the stomach, a wide portion of intestine reaches to opposite the lower extremity of the stomach, and presents a very glandular structure, being pitted closely over with clear little follicles. At the end of this duodenum the intestine is suddenly contracted and convoluted. The contracted portion is about twice the length of the duodenum, and opens into a straight and dilated rectum.

The anterior part of the abdominal cavity is deepened by the manner in which the transverse processes are given off from the anterior vertebræ, and the depth so gained is divided into two fossæ on each side of the vertebral column by the perpendicular direction of the spring process. The anterior fossa, situated between the spring process and the occiput, is filled by a lobe of liver; the posterior, behind the spring process, is occupied by the anterior part of the swimming-bladder.

The liver is of a square form, composed of two symmetrical lobes, and from the upper part on each side comes off, by a constricted pedicle, the lateral lobe which occupies the anterior fossa. A large gall-bladder receives the bile by a hepatic duct from each side of the liver, and opens by a bile-duct immediately beyond the pylorus.

No spleen is to be found in any of the specimens, but a chain of masses of fat, broken into irregular angles like the spleen of a carp, lies on the left side of the stomach and in front of the rectum (probably a degenerated spleen).

The swimming-bladder is divided by a constriction opposite the seventh and eighth vertebræ into two parts. The anterior part occupies the fossa behind the spring process, and is somewhat quadrangular; the posterior, the largest, passes back nearly the whole length of the abdomen. The constricted part has less than a third of the widest diameter. From the centre of the anterior division the pneumatic duct comes off; it is short and straight, and enters the superior wall of the œsophagus. On opening the swimming-bladder, it is seen to be divided by a septum down the middle, which reaches from its hinder extremity to the posterior margin of the body of the fused vertebræ, where it ends in a free margin, in which the pneumatic duct commences. The orifice between the anterior and posterior division of the bladder, on each side of the septum, is only large enough to admit a probe. Four or five rings of muscular fibre encircle at intervals each half of the bladder posteriorly, projecting into it.

The kidneys are but loosely connected with the abdominal wall, and are dilated at their anterior extremities, which fit in on each side of the constriction of the swimming-bladder.

The urinary bladder is very largely developed, and is thrown into numerous loculi.

The testes and ovaries were empty in the specimens examined; the testes were long and slender,—the ovaries short and thick.

EXPLANATION OF PLATES.

Plate I.

Fig. 1. View from above of the bones of the head and the modified vertebræ.

2. View from below of the same.

These two figures, and Plate II., Fig. 1, are marked with the same series of letters and numbers—*a* supra-occipital bone—*b* ex-occipital—*c* par-occipital—*d* basi-occipital—*e* mastoid—*f* great frontal—*g* post-frontal—*h* ali-sphenoid—*i* basi-sphenoid—*k* orbito-sphenoid—*l* inter-orbital plate—*m* pre-frontal—*n* nasal bone—*o* vomer—*p* inter-maxillary—*q* supra-maxillary—*r* palate bone—*s*, *t*, *u*, *v*, pterygo-tympanic range, viz., *s* pterygoid, *t* hypo-tympanic, *u* epi-tympanic, *v* sympletic—*w* opercular—*x* inter-opercular bone—*y* supra-temporal cartilage—*z* infra-orbital range—*a'* dental piece of the lower jaw—*b'* articular piece. 1. Transverse process of the second vertebra (springfederfortsatz)—2. Stem process—3. Malleus—4. Stapes—5. Neurapophysis of first vertebra—6. Thread-like process of third vertebra—7. Body of first vertebra—8. Body of second vertebra—9. Dorsal arch of second and third vertebra conjoined—10. Transverse processes of third vertebra—11, 12. Spinous and transverse processes of fourth vertebra—13. Transverse process of fifth vertebra—14. Posterior articular process—15. Scapula, the ligament joining it to the basi-occipital being represented by a dotted line—β. The outlet of the Y-shaped canal, in which the aorta commences—γ lateral opening of the same—δ olfactory foramen of the pre-frontal bone.

Fig. 3. Vertical section of the modified vertebræ, showing the division of the conjoined body into three portions by lines—γ lateral opening of the Y-shaped canal—δ, ε, ζ foramina for nerves.

Fig. 4. *a* Coracoid bone—*c* radio-ulnar bone—*b* these bones united, and the two carpal bones in the position which they occupy when the fin lies close to the body.

Fig. 5. The hyoid arch—*a* basihyal—*b* epihyal—*c* ceratohyal—*d* stilohyal bone—*e* pterygo-tympanic range—*f* lower jaw—*g* urohyal bone The ligaments are shown by which the hyoid arch is hung.

Fig. 6. The pelvic bones.

Fig. 7. Two posterior trunk and two anterior caudal vertebræ.

Fig. 8. Terminal caudal vertebræ.

Plate II.

Fig. 1. Profile view of the bones of the head and modified vertebræ. (For the letters and numbers see above.)

Fig. 2. View of muscles on the abdominal aspect—*a* pectoralis muscle—*b, b* recti muscles—*c, c* anterior pelvic muscles—*d* ligament supporting the pelvis—*e, f* depressor and levator of the pectoral fin—*g* space uncovered by muscle, the anterior part of which corresponds to the fossa which contains the lateral lobule of liver.

Fig. 3. View of muscles on the dorsal aspect—*a* pectoralis muscle—*b* space uncovered by muscle between the pectoralis and anterior part of the great lateral muscle, with the transverse process of the third vertebra seen projecting under the membraneous covering—*c, d* masseter muscle above and below the eye-ball—*e* attachment of the other masseter to the lower jaw—*f* muscle passing from the tympanic range to the supra-maxillary bone—*g* levator of the operculum *w*,—*i i* the eyeballs—*k* coracoid bone and pectoral fin—*y* supra-temporal cartilage—*z* cartilaginous clavicle. The muscles from the mastoid bone to the operculum and coracoid bone are seen crossed by the last two structures.

Fig. 4. View of the viscera—*a* stomach—*b* glandular duodenum—*c* rectum—*d* liver partially raised, and the right lateral lobule exposed, while the left is hid in the fossa in which it lies—*e* electric nerve—*f* gall-bladder—*g* bile-duct—*h* swimming bladder—*i, i* kidneys—*k, k* ovaries—*l* lobulated urinary bladder.

Fig. 5. Swimming bladder, with pneumatic duct.

Theory of Linear Vibration—(continued). By EDWARD SANG, Esq., F.R.S.E.

V.—*Transmission of an Impulse.*

The problem "To determine the velocity of sound" may be expressed by the analogous problem "To discover the manner in which a blow upon one end affects a discrete elastic series."

Whatever may be the motions of such a series, it may be regarded as the result of a succession of impulses, each of which was sufficient to produce one of the simple vibrations into which the motion may be decomposed: and thus, whether the system be at rest or in motion, an impulse communicated to one of its parts will produce the same change. Hence, if we can discover what effect an impulse communicated to any one of the series when in repose has upon the system, we shall be able to compute what would be the result of an impulse communicated while the system is vibrating.

If we suppose, then, that while all the bodies A, B, ... L, M, of the series are in a state of repose, some one of them, as F, receives a sudden impulse, the whole condition of the system will, instantly, be affected; its parts will have impressed upon them the velocities due to the state of vibration induced by the blow, and their positions will at once be rigidly subjected to the conditions contained in equation (44). If, for example, the blow be given at the end M, the body A at the other extremity will instantly begin to move; its position will instantly be subjected to the law $x_{\text{A}} = \Sigma a_\nu \text{U}_\nu \sin(t\theta_\nu + u_\nu)$, and will continue to be subjected to that law until the system receive another impulse. Nor would the statement be essentially affected by the supposition that the system had been in motion at the time of the impulse, for if $x_{\text{A}} = \Sigma a'_\nu \text{U}'_\nu \sin(t\theta_\nu + u'_\nu)$ had been the law of motion of A previous to the blow, its new law of motion would have been obtained by merely adding these together, and would have resulted in an equation of the same form as either.

So, exactly in the same way, if we suppose a system of planets, say the actual solar system, revolving in their complicated paths, and if we imagine a sudden change to take place in any one of them; if we imagine, for instance, that Mars receives a sudden blow, changing at once the figure and magnitude of its orbit; the law of motion of every one of the planets would instantly be changed. It is true that time would be required in order that astronomers might be enabled to recognise the effects of the change; but the change itself would at once exist in all its integrity.

This we must admit, unless we can imagine that some interval of time elapses before the attraction of one planet becomes felt at another. The idea of pressure, or of that modification of pressure to which we give the name *attraction*, is altogether independent of time; and thus, when we speak or think of two planets attracting each other, we imagine that the attraction exists between them in their simultaneous positions, and that its direction and intensity are regulated as if each body were, so to speak, conscious of the actual position and distance of the other. The tendency, for example, of the Earth to move towards Neptune, or the attraction between the Earth and Neptune at the present instant, is directed towards the very place which Neptune at this moment occupies; not to the point which Neptune did occupy at the time at which he sent off the message "*Here I am*" to Tellus.

The instant, then, that the extreme body M of our elastic series is disturbed, that instant the disturbance is felt at A; A begins to be displaced, and before we can proceed to inquire, "In what time is the impulse received by M transmitted to A?" we must ascertain, first of all, what is the law of A's motion as resulting from that impulse; and thereafter we must define what phase of that motion is to be regarded as indicating the transmission.

In order to trace the effects which a blow received by M will have upon the system, we shall suppose that while the bodies A, B, ... K, L, are in their mean positions, and at rest as to absolute space, the last body M has impressed upon it a velocity which, for the sake of convenience, I shall denote by nv. In that case the centre of gravity of the system would move with the velocity v, and therefore the relative velocities of all the bodies from A to L would be $-v$, while the velocity of M in respect to the centre of gravity would be $(n-1)v$. That is to say, we have

$$(x_A)=0,\ (x_B)=0,\ (x_C)=0\ \ldots\ldots\ (x_L)=0$$
$$(v_A)=-v,\ (v_B)=-v;\ (v_C)=-v,\ \ldots\ (v_L)=-v,$$

and these values, put in equations (64) and (65) are, sufficient to determine all the future motions of the system.

The first set give at once $(u_1)=0$, $(u_2)=0$, &c., whence we conclude that the angles u_ν are all zeroes, and that the quantities (u'_ν) are identic with U_ν.

Since the equations (65) are linear in regard to the quantities (U'_ν), a change in the value of v would produce a proportional change in all of these quantities; that is to say, it would alter the extents, but not the characters, of the oscillations. We may then, for the sake of simplicity, make $v=2\sqrt{\frac{e}{w}}$, and at the same time we may put

$$\varphi=\frac{\pi}{2n},$$

and then equations (65) take the more convenient form

$$\begin{aligned}
-1&=U_1\cos\ \varphi.\sin\varphi+U_2\cos\ 2\varphi.\sin 2\varphi+U_3\cos\ 3\varphi.\sin 3\varphi+\&c.\\
-1&=U_1\cos 3\varphi.\sin\varphi+U_2\cos\ 6\varphi.\sin 2\varphi+U_3\cos\ 9\varphi.\sin 3\varphi+\&c.\\
-1&=U_1\cos 5\varphi.\sin\varphi+U_2\cos 10\varphi.\sin 2\varphi+U_3\cos 15\varphi.\sin 3\varphi+\&c.\\
&\quad +\&c. \qquad\qquad +\&c. \qquad\qquad +\&c.
\end{aligned}$$

And here again, observing that each U^ν is multiplied throughout by $\sin\nu\varphi$, we may obtain a still greater simplification by putting

$$Q_\nu = U^\nu \sin\nu\varphi,$$

which gives to the equations the form

$$\begin{aligned}
-1&=Q_1\cos\ \varphi+Q_2\cos\ 2\varphi+Q_3\cos\ 3\varphi+\&c.\\
-1&=Q_1\cos 3\varphi+Q_2\cos\ 6\varphi+Q_3\cos\ 9\varphi+\&c.\\
-1&=Q_1\cos 5\varphi+Q_2\cos 10\varphi+Q_3\cos 15\varphi+\&c.\\
&\ldots\ldots\ldots\ldots\ldots\ldots\\
-1&=Q_1\cos(2n-3)\varphi+Q_2\cos(2n-3)2\varphi+Q_3\\
&\qquad\cos(2n-3)3\varphi+\&c. \qquad . \qquad . \qquad (67)
\end{aligned}$$

Since $2n\varphi=\pi$, the terms of the last of these equations are equal to those of the second, with the signs alternately changed; and so of each pair of equations, counting upwards and downwards until we meet in the middle: the want of the nth equation prevents the whole from being symmetric, and renders it difficult to obtain any general formulæ of elimination. It is enough for my present purpose to examine one or two cases in detail.

CASE I.—*Two Bodies.*

When the system consists of two equal bodies A and B, we have $\varphi = 45°$, and the solitary equation (67) becomes

$$-1 = Q_1 \cos 45°, \text{ or}$$

$$-v \,.\, \tfrac{1}{2}\sqrt{\frac{w}{e}} = U_1 \sin 45° \,.\, \cos 45° ; \text{ wherefore}$$

$$U_1 = -v\sqrt{\frac{w}{e}},$$

and therefore the equations which contain the future motions of the system are

$$x_{A} = -v\sqrt{\frac{w}{e}} \,.\, \cos 45° \sin\left(2t\sqrt{\frac{e}{w}} \,.\, \sin 45°\right)$$

$$\text{or} \quad \left.\begin{array}{l} x_{A} = -v\sqrt{\dfrac{w}{2e}} \,.\, \sin\left(t\sqrt{\dfrac{2e}{w}}\right) \\ x_{B} = +v\sqrt{\dfrac{w}{2e}} \,.\, \sin\left(t\sqrt{\dfrac{2e}{w}}\right) \end{array}\right\} \quad . \; . \; . \quad (70.)$$

in reference to its centre of gravity. But as the whole system is moving with the mean velocity v, the positions of A and B in space, and their absolute velocities, are

$$\left.\begin{array}{l} x'_{A} = vt - v\sqrt{\dfrac{w}{2e}} \,.\, \sin\left(t\sqrt{\dfrac{2e}{w}}\right) \\ x'_{B} = vt + v\sqrt{\dfrac{w}{2e}} \,.\, \sin\left(t\sqrt{\dfrac{2e}{w}}\right) \end{array}\right\} \quad . \; . \quad (71).$$

$$\left.\begin{array}{l} {}_{1t}x'_{A} = v - v \cos\left(t\sqrt{\dfrac{2e}{w}}\right) \\ {}_{1t}x'_{B} = v + v \cos\left(t\sqrt{\dfrac{2e}{w}}\right) \end{array}\right\} \quad . \; . \; . \quad (72.)$$

Here the velocity of A is zero when $\cos\left(t\sqrt{\frac{2e}{w}}\right) = +1$, which happens when $t\sqrt{\frac{2e}{w}} = 0,\ 2\pi,\ 4\pi$, &c., at which times the velocity of B is $2v$. And the velocity of B is zero, when $\cos\left(t\sqrt{\frac{2e}{w}}\right) = -1$; that is, when $t\sqrt{\frac{2e}{w}} = \pi,\ 3\pi,\ 5\pi$, &c., at which times the velocity of B is $2v$. The body A then acquires the full velocity given to the body B in an interval of time

$$(\psi_A) = \pi\sqrt{\frac{w}{2e}} = \sqrt{\frac{w}{e}} \times 2{\cdot}221\ 441 \quad . \quad . \quad (73.)$$

After a second interval (ψ_A), the velocities of the two bodies will be as at first; after another interval A will have acquired again its maximum velocity, and B will be stationary, the linear interval between the successive resting-places being

$$2(\psi_A)\, v = v\sqrt{\frac{w}{e}} \times 4{\cdot}442\ 882.$$

Here it is to be observed that this investigation does not recognise any interval of time between the commencement of the motion of B, and the beginning of that of A; the time (ψ_A) is that which elapses between the blow on B and the complete communication of that impulse to A.

Case 2.—*Three Bodies.*

When the system consists of three bodies A, B, C, and when the third body C receives, by impact, the velocity $3v$, the equations become

$$-1 = Q_1 \cos 30° + Q_2 \cos 60°$$
$$-1 = Q_1 \cos 90° + Q_2 \cos 180°; \text{ whence}$$
$$U_1 = -v\sqrt{\frac{3w}{e}}\,;\quad U_2 = +v\sqrt{\frac{w}{3e}}.$$

And therefore the vibrations of the system, induced by a blow upon C, are represented by the equations

$$x'_A = vt + v\sqrt{\frac{w}{e}}\left\{-3\sqrt{\frac{3}{4}}\sin\left(t\sqrt{\frac{e}{w}}\right) + \frac{1}{2}\sin\left(t\sqrt{\frac{3e}{w}}\right)\right\}$$

$$x'_B = vt + v\sqrt{\frac{w}{3e}}\left\{ \qquad\qquad\qquad\qquad - \sin\left(t\sqrt{\frac{3e}{w}}\right) \right\}$$

$$x'_C = vt + v\sqrt{\frac{w}{3e}}\left\{ + 3\sqrt{\frac{3}{4}}\sin\left(t\sqrt{\frac{e}{w}}\right) + \frac{1}{2}\sin\left(t\sqrt{\frac{3e}{w}}\right) \right\} \tag{76.}$$

which gives the positions of the bodies at any future time t; and by

$$_{1t}x'_A = v\left\{ 1 - \frac{3}{2}\cos\left(t\sqrt{\frac{e}{w}}\right) + \frac{1}{2}\cos\left(t\sqrt{\frac{3e}{w}}\right) \right\}$$

$$_{1t}x'_B = v\left\{ 1 \qquad\qquad\qquad\qquad - \cos\left(t\sqrt{\frac{3e}{w}}\right) \right\}$$

$$_{1t}x'_C = v\left\{ 1 + \frac{3}{2}\cos\left(t\sqrt{\frac{e}{w}}\right) + \frac{1}{2}\cos\left(t\sqrt{\frac{3e}{w}}\right) \right\} \tag{77.}$$

which give their absolute velocities at the same instant of time.

An examination of these shows, as indeed we might have expected, that the middle body B is subject to only one oscillation, the rapidity of which is proportional to $\sqrt{3} + \sqrt{\frac{e}{w}}$; the slower oscillation with the rapidity $\sqrt{\frac{e}{w}}$ is performed so that the two bodies A and C approach to and recede from B, which, so far as that oscillation is concerned, remains at rest; it is also to be remarked that this, the slower of the two oscillations of three bodies, is performed with the fundamental velocity $\sqrt{\frac{e}{w}}$, represented by the radius of the circle in figure, page 45.

The second body B can never acquire a velocity greater than $2v$; that is, than two-thirds of the velocity originally communicated to C.

The body A, on the other hand, never can acquire the full velocity $3v$, since, in order to that, we must have

$$-3\cos\left(t\sqrt{\frac{e}{w}}\right) + \cos\left(t\sqrt{\frac{3e}{w}}\right) = 4,$$

a condition which can only be satisfied when

$$t\sqrt{\frac{e}{w}} = (2m+1)\pi, \quad t\sqrt{\frac{3e}{w}}\Big) = 3n\pi.$$

Now the ratio of no two integers $2m+1$ and $2n$ can be exactly that of radius to the chord of 120°, and therefore this coincidence can never occur. On solving by approximation the equation

$$\frac{2n}{2m+1} = \sqrt{3},$$

we find the successive solutions $\frac{2}{1}, \frac{26}{15}, \frac{362}{209}, \frac{5042}{2911}$, &c., the scale of progression being 14 and -1; therefore, after 26 half oscillations in the longer, and 15 half oscillations in the shorter periodic time (which periods are nearly equal to each other), the whole motion of the system will be very nearly accumulated in the body A. The concentration of the whole motion in the body A will be more nearly completed towards the time

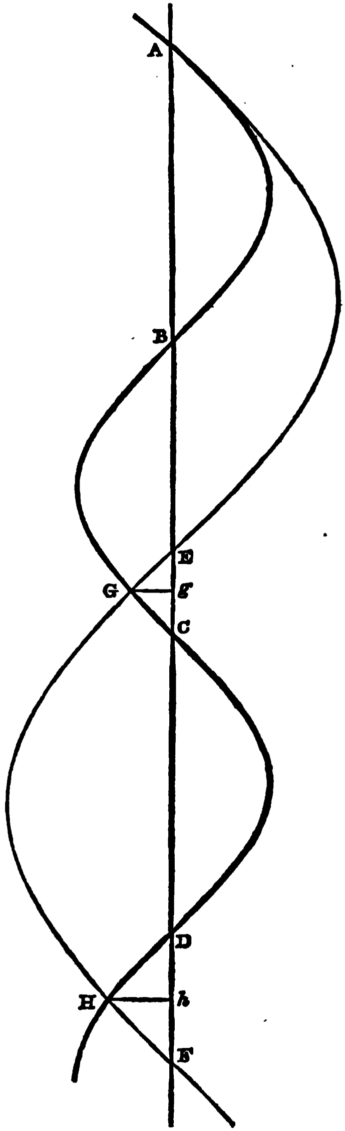
$$t = 209\pi\sqrt{\frac{w}{e}}, \text{ and } t = 362\,\pi\sqrt{\frac{w}{3e}}.$$

From this it is clear that the transmission of sound along a column of air cannot be represented by the transmission of the full force of the blow from the body C to the body A,

Long before A has acquired nearly the whole motion of the system, its velocity has reached a maximum, become retrograde, and again reached a maximum, the interval of time between the impact and the instant of the first maximum velocity may better represent the time needed to transmit a blow from C to A.

On equating the second derivative of x_A to zero, or, what comes to the same thing, on making $x_A = x_B$, we obtain, for the instant of A's velocity being a maximum,

$$\sqrt{3} \,.\, \sin\left(t\sqrt{\frac{e}{w}}\right) = \sin\left(t\sqrt{\frac{3e}{w}}\right) \quad . \quad . \quad . \quad (79.)$$



The roots of this highly transcendental equation may be represented by the annexed diagram. Having laid off the equal distances AB, BC, CD, &c., construct a curve of sines passing through the points A, B, C, D, &c., and continue this curve indefinitely. Then laying off AE, EF, &c., equal to the chords of 120°, in a circle of which AB is the radius; construct a second curve of sines passing through the points A, E, F, &c., the intersections G, H, &c., indicate those times at which the body A has its velocity maximum. The intervals of time between the occurrences of this phase are proportional to A*g*, *gh*, &c., AC representing the time of a fundamental oscillation.

On computing carefully we find

$$Ag = 193^\circ\ 46'\ 45'' = 3{\cdot}383085 \quad . \quad (79.)$$

Now the body B acquires its first maximum velocity when $t\sqrt{\frac{3e}{w}} = \pi$; that is, when $(\psi_B) = \sqrt{\frac{w}{e}} \times 1{\cdot}813800$, and thus the time in which A acquires its first maximum velocity is somewhat less than double of the time in which B acquires its first maximum velocity. On comparing this result with (73), we observe that the time occupied in transmitting what may be called the first impulse along two steps of the series is about one-half more than the time in which it was transmitted one step; the times being nearly proportional to the numbers of the bodies in the two systems.

CASE 3.—*Four Bodies.*

When the system consists of four equal bodies A, B, C, D, equations (67) become

$$-1 = Q_1 \cos \frac{\pi}{8} + Q_2 \cos 2\frac{\pi}{8} + Q_3 \cos 3\frac{\pi}{8}$$

$$-1 = Q_1 \cos 3\frac{\pi}{8} + Q_2 \cos 6\frac{\pi}{8} + Q_3 \cos 9\frac{\pi}{8}$$

$$-1 = Q_1 \cos 5\frac{\pi}{8} + Q_2 \cos 10\frac{\pi}{8} + Q_3 \cos 15\frac{\pi}{8}$$

whence

$$U_1 = v\sqrt{\frac{w}{e}} \left\{ -\sqrt{2} - 1 \right\}$$

$$U_2 = v\sqrt{\frac{w}{e}} \left\{ \quad +1 \right\}$$

$$U_3 = v\sqrt{\frac{w}{e}} \left\{ -\sqrt{2} + 1 \right\} \quad . \quad . \quad . \text{(81.)}$$

and from these values of U_1, U_2, U_3, we obtain, by help of equations (61), the following values for the ordinates of the several bodies in absolute space:—

$$x'_A = vt + v\sqrt{\frac{w}{e}} \left\{ + \left(-1 - \sqrt{\frac{1}{2}}\right)^{\frac{3}{2}} \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{\pi}{8}\right) \right.$$

$$+ \left(+ \quad \sqrt{\frac{1}{2}}\right) \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{\pi}{4}\right)$$

$$\left. + \left(-1 + \sqrt{\frac{1}{2}}\right)^{\frac{3}{2}} \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{3\pi}{8}\right) \right\}$$

$$x'_B = vt + v\sqrt{\frac{w}{e}} \left\{ -\sqrt{\left(\frac{1}{2} + \frac{1}{2}\sqrt{\frac{1}{2}}\right)} \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{\pi}{8}\right) \right.$$

$$+ \left(- \sqrt{\frac{1}{2}}\right) \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{\pi}{4}\right)$$

$$\left. + \sqrt{\left(\frac{1}{2} - \frac{1}{2}\sqrt{\frac{1}{2}}\right)} \sin\left(2t\sqrt{\frac{e}{w}} \sin\frac{3\pi}{8}\right) \right\}$$

$$x'_{\text{C}} = vt + v\sqrt{\frac{w}{e}}\left\{ +\sqrt{\left(\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}}\right)} \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{\pi}{8}\right) + \left(-\sqrt{\frac{1}{2}}\right) \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{\pi}{4}\right) - \sqrt{\left(\frac{1}{2}-\frac{1}{2}\sqrt{\frac{1}{2}}\right)} \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{3\pi}{8}\right) \right\}$$

$$x'_{\text{D}} = vt + v\sqrt{\frac{w}{e}}\left\{ + \left(1+\sqrt{\frac{1}{2}}\right)^{\frac{3}{2}} \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{\pi}{8}\right) + \left(+\sqrt{\frac{1}{2}}\right) \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{\pi}{4}\right) - \left(1-\sqrt{\frac{1}{2}}\right)^{\frac{3}{2}} \sin\left(2t\sqrt{\frac{e}{w}}\sin\frac{3\pi}{8}\right) \right\} \quad (82.)$$

By taking the first derivatives of these we obtain the velocities of the several bodies; and by equating the second derivatives to zero, we can determine the instants at which any one of the bodies has its velocity maximum or minimum.

The resulting equations are enormously complex, involving the sines of three angles, all incommensurate. In order to discover when C has its velocity maximum, we must resolve the equation

$$\sin\frac{\pi}{8} \cdot \sin\left(2\psi\sin\frac{\pi}{8}\right) - \sin\left(2\psi\sin\frac{2\pi}{8}\right) - \sin\frac{3\pi}{8} \cdot \sin\left(2\psi\sin\frac{3\pi}{8}\right) = 0,$$

and similarly intricate equations for the other bodies.

The actual solutions of these give, for the times at which C, B, and A attain their first maximum velocities, the results

$$t = \sqrt{\frac{w}{e}} \times 1{\cdot}805\,645 \text{ for C},$$

$$t = \sqrt{\frac{w}{e}} \times 3{\cdot}008\,380 \text{ for B},$$

$$t = \sqrt{\frac{w}{e}} \times 4{\cdot}494\,533 \text{ for A}.$$

This line of investigation has now been pursued far enough to show that even although we could obtain a general solution of the equations involving U and u for any conceivable combination of impulses; the resulting formulæ for the motions of the various bodies of the system would remain unmanageable, on account of the circumstance that the periodic times of the oscillations are incommensurate. This circumstance also prevents us from even supposing that the oscillations of a perfectly elastic linear series can ever take the form of simple undulations.

Any blow upon one body of such a series calls into existence every oscillation of which that series is capable, and, in order to produce a simple oscillation, an impulse, properly computed and properly timed, would need to be given to each body, save one, of the series.

In order to determine theoretically the manner in which an impulse affects a concrete elastic system, we must augment indefinitely the number of the minute parts into which we suppose it to be divided; and having thus obtained an infinite number of equations, each containing an infinite number of doubly-transcendental terms, we would need to resolve them.

Such are the formidable difficulties which stand in the way of a problem which is believed to have been resolved in a satisfactory though somewhat off-hand manner; and the solution of which M. le Compte Laplace disposes of in the easy words, "*Comme on sait et comme il est facile à dèmontrer.*"

On the Discovery of the Remains of an ancient Iron-Smelting Furnace or "Bloomery," at Lochgoilhead, Argyleshire, with Analysis of the Furnace Slag. By John J. J. Kyle, Assistant in the Chemical Laboratory, School of Arts and Surgeons' Hall, Edinburgh.*

The exact period when the ancient inhabitants of Great Britain first practised the art of metallurgy, as applied to the manufacture of iron, must ever remain a matter of uncertainty and dispute. We have the authority of Cæsar for stating that when the Romans under his command invaded the British Isles, they found the inhabitants making use of iron rings and tallies (*taleæ ferreæ*) as a substitute for coins, which it is possible the aborigines may have obtained in exchange for the tin which at that time they employed in bartering with the Phœnicians for different commodities. Though it may be an open question whether the knowledge of smelting iron was possessed by the Britons prior to the time of the Roman invasion, or was introduced by the Romans themselves, this much is certain, that the birth of our iron manufacture may be dated from about that time. This appears demonstrated by the fact that ancient beds of iron scoria have been discovered, in which Roman coins have been found. These beds of scoria are met with in many parts of the country, more especially in England; and are chiefly interesting as being so many archæological relics which point out to the inquirer the precise spots where our forefathers once practised the metallurgic art; and, it may be, occasionally indicating to us the existence in their vicinity of stores of mineral treasure, which, during the lapse of centuries, have been forgotten, or the working of which may have been abandoned from a scarcity of the particular fuel at that time deemed necessary for the reduction of the metal from its ore.

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* Read before the Chemical Section of the British Association, Dublin, 1857.

The object of the present communication is very briefly to direct attention to the existence of a bed of ancient scoria, which was discovered by me, during the autumn of 1856, at Lochgoilhead, a small village at the northern extremity of Loch Goil, in the Western Highlands of Scotland. One day I chanced to pick up a small piece of a heavy, dark-coloured slag from amongst the protruding roots of some trees growing in an unfrequented part of a wood near the shores of the loch, and at the base of one of the mountains, the rugged slope of which is covered with large masses of rock, and is known as "Argyle's Bowling-Green." The occurrence of this relic of industrial art in a situation so far removed from any existing blast furnaces led me, in conjunction with my friend Dr Stevenson Macadam, to make a closer investigation of the neighbouring ground near which the first specimen had been picked up. We were not long in discovering, at the depth of a few inches beneath the surface soil, now thickly covered with brushwood, great quantities of the slag, as also small portions of charcoal, which had doubtless been the fuel employed in smelting the iron. Pieces of stone were likewise observed, which, from their calcined appearance had evidently formed part of the rude structure which had served as a substitute for our modern blast-furnaces. It now became apparent that we stood on the site of an ancient bloomery, though, on inquiry at the inhabitants of the district, I was unable to gain any information, historical or traditional, tending to confirm the opinion that the manufacture of iron had at any time been carried on in the district.

The slag referred to is of a blackish colour, is somewhat vesicular, has a vitreous fracture, and on analysis yielded to me the following results:—

Silica, ...	29·06
Alumina, ...	5·60
Lime, ...	2·80
Magnesia, ...	3·72
Protoxide of Iron, ...	56·50
Sulphide of Calcium, . . .	1·00
Loss, with trace of Manganese, . .	·76
	100·00

The above analysis represents a slag which is essentially a double silicate of alumina and protoxide of iron, together with a little lime and magnesia. The oxygen in the combined bases considerably exceeds that in the silicic acid, a fact which is the reverse of that generally observed in the analysis of modern iron slags; experience having shown that the slag possessed of the highest degree of fusibility is that in which the proportion of oxygen in the acid is exactly double that in the base.

The composition of the Lochgoil slag is sufficient to show that the process of manufacture employed in this bloomery was most likely that known as the direct or Catalan process; one still adopted on the Continent to a small extent, and by which method the ore, either in its raw condition or previously subjected to a preliminary roasting, is reduced to the metallic condition by the direct action of the fuel, and without the intervention of any flux, such as limestone. The silicic acid present in the ore is compelled, for the most part, to combine with the protoxide of iron, giving rise to the formation of a slag of a highly fusible character,—a matter of great importance when we take into consideration the simple and imperfect appliances at command of the operators in those remote regions and early times.

It has long been remarked, that the scoria found on elevated positions generally contained a large amount of oxide of iron, whilst those produced from bloomeries situated on less elevated districts more closely resembled the slag run off from furnaces of the present day, and had little iron in their composition. From this circumstance it has been inferred that, prior to the introduction of bellows as a means of forcing air into the burning fuel, the bloomeries were placed on positions as elevated as possible, where the natural currents of air could have more ready access to the combustible. Notwithstanding this expedient, however, the temperature thus attainable must still have been much less intense than where artificial methods were had recourse to for this purpose. Consequently the employment of lime, with the view of separating the siliceous matter of the ore, was impracticable, the calcareous silicate thus formed being of too infusible a nature to admit of its being readily formed and run off from the furnace.

Judging from the results of my analysis, and from these various considerations, I am led to the conclusion that the bloomery at Lochgoilhead was one of the most ancient in the kingdom, and although situated at no very great height above the sea level, its position would still be one well adapted for carrying on with success the manufacture of iron by the most primitive method, as through the valley sudden and high winds are, in one direction or another, almost constantly sweeping. In concluding this notice, I may state that I have been unable to prove the existence of deposits of iron ore of any extent in the vicinity of Loch Goil, and therefore cannot offer any opinion as to the source of the ore employed in this bloomery.

Chemical Analysis of Faröelite, and some other Zeolites, occurring in Nova Scotia. By HENRY HOW, Professor of Chemistry and Natural History, King's College, Windsor, Nova Scotia.

The minerals forming the subject of the present communication were obtained from the trap rock of the Bay of Fundy, which is well known to mineralogists, particularly of America, as having yielded, especially at the point of land called Cape Blomidon, and the regions on the northern shore opposite Partridge Island, a great number of beautiful zeolitic minerals. In excursions to another part of the same formation not so frequently visited, namely, the shore of Annapolis County, lying a few miles to the west of Blomidon, I met with some species, viz., Faröelite, Mesolite, and Epistillite, which are not generally considered to occur in Nova Scotia; and indeed, the first two having somewhat recently been separated from others as true species, in Europe, have not, I think, been hitherto distinguished among the minerals of America. The analytical results now to be brought forward may possess an interest, not only as indicating the existence of these minerals in North America, but as strengthening their claims to the title of true species, which has been given them chiefly on the ground of chemical composition.

In addition is furnished an analysis of an unweathered specimen of Laumontite, long known as occurring among the Acadian zeolites, but met with only in certain districts of the Fundy shore affording them.

Faröelite.—This zeolite, which has long passed as a variety of scolezite, under the name of mesole, has recently been carefully studied by Dr Heddle,* and the results of his investigations have led him to consider it as a distinct species. He has accordingly named it anew, and in this I think he has done well, inasmuch as the name he has chosen marks at once the individuality of the mineral, and the locality affording him the material for experiments on which he has based his conclusions. The description given of its characteristic appearance and association is this:* "It occurs associated with mesolite, but still always distinct from it, being in implanted and isolated globules or hemispheres, sometimes overlaid, but never underlaid, by the mesolite. The colour is usually bluish-white, and the lustre decidedly pearly, not glassy, like the mesolite." I met with specimens having, in every particular, such characters, in the trap cliff in the neighbourhood of a small fishing village called Port George, in Annapolis County, Nova Scotia; and, from having obtained some dozen specimens in the course of three or four hours' search for minerals, I have little doubt of its being tolerably abundant in that locality. The hardness of the mesole of Berzelius is stated to be 3·5; the specimens of the Nova Scotia mineral whose analysis is given below had hardness = 4·5; very thin laminæ of it, which it afforded very easily, twisted before the blowpipe, and fused in a good heat to a glossy enamel, and it gelatinized with hydrochloric acid before and after ignition.

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* Edin. New Phil. Journal, 1856, vol. iii., p. 351.

The analytical numbers I obtained are collated with those of Heddle from the Skye mineral; my first two analyses were on air-dry material, the third on that dried over sulphuric acid:—

	Scotland, Heddle.			Nova Scotia, How.		
	I.	II.	III.	I.	II.	III.
Soda, . .	5·77	4·38	5·33	5·00	3·75†	5·58
Lime, . .	11·54	11·40	9·82	11·70	11·92	11·52
Alumina, .	28·44	30·00	29·30	29·31	29·98	29·52
Silica, . .	41·32	41·20	43·17	41·41	41·48	40·90
Water, . .	13·26	13·20	12·40	12·83	12·87	12·49
	100·33	100·18	100·02	100·25	100·00	100·01

It will be seen at once that the results are very concordant, and that we have the same combination in both cases. The oxygen ratio deduced for RO, R_2O_3, SiO_3, HO is very nearly $1:3:5\frac{2}{3}$, upon the average of the analyses; and Dr Heddle writes, as the formula of Faröelite,

$$NaO\,SiO_3,\ 2\,CaO\,SiO_3 + 3\,Al_2O_3,\ 2\,SiO_3 + 8\,HO,$$

which requires the per-centages—

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* Fourth Supplement to Dana's Mineralogy. Amer. Journ. of Science and Art, July 1858, p. 118.

† By deficiency.

Soda, . . .	5·74
Lime, . . .	10·37
Alumina, . . .	28·57
Silica . . .	41·96
Water, . . .	13·34
	100·00

In the course of criticism,* Dana remarks, that the ratio of oxygen in Heddle's second analysis is rather $1:3:4\frac{1}{2}:2\frac{1}{2}$ (that of a hydrous nepheline) $= RO^2\ SiO_3 + 2Al_2O_3\ SiO_3 + 5HO$ (in which $2RO = NaO + 1\frac{1}{3}\ CaO$) = silica 40·25, alumina 29·83, lime 10·84, soda 6·00, water 13·08 = 100. My analyses would agree rather better with these per-centages than with those of Heddle's formula; but still, as Dana says, "probably the preceding is the true ratio for the mineral;" and, moreover, the recorded analyses† of nepheline do not give more than 2 per cent. of lime.

Mesolite.—The mineral mentioned as the associate of Faröelite—viz., mesolite—is very much the more abundant of the two, forming the larger proportion of specimens in which they occur together, and is found not only in this association, but filling *per se* cavities in the amygdaloid. It would also appear to be very frequent throughout the formation in the same neighbourhood, and is sometimes met with in very large masses. I procured the remains of one said by the owner, who gave it me, to have been found in a cavern on the shore, since filled up, and to have been originally larger than a man's head; the piece I obtained was about the size of two fists. The crystals of which it was made up into a compact mass, were from two to three inches long, and translucent when separated. The specimen was nearly homogeneous, having only a little stilbite attached to it, but was impressed with the form of a very large crystal of analcine. Its analysis is No. I. below. Mesolite is said to be also very abundant on the North Mountains of Annapolis, some distance away from the shore; the form prevalent, from a specimen of my collecting being recognized as very common there by the owner of that last named, is that of an opaque white mineral, in large masses of very close texture, having a finely fibrous, radiated, and penniform structure. This specimen furnished the results II. below. The third analysis is of a specimen found by myself at Port George. It was associated with Faröelite in a reniform mass, and when broken up, the fragments appeared nearly transparent, and the aggregated crystals were prismatic.

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* *Loc. cit.*

* Nicol's Mineralogy, p. 140.

The results of analyses I., II., III., were these:—

	Dried at 212°.		Dried over HSO_4	Calculated.
	I.	II.	III.	
Soda, . .	5·21	4·45*	5·68	5·29
Lime, . .	9·63	9·63	9·55	9·57
Alumina, .	25·92	27·04	26·68	26·36
Silica, . .	46·84	46·48	46·71	46·46
Water, . .	12·11	12·40	11·42	12·30
	99·79	100·00	100·04	100·00

and they agree very well with the per-centages placed in juxtaposition calculated from the formula

$$NaO\,SiO_3,\ 2CaO\,SiO_3 + 3(Al_2O_3\,SiO_3) + 8HO,$$

given by Heddle† as that of "mesolite," and also by Berzelius,‡ as representing the constitution of "lime and soda scolezite."

It is interesting to observe, on comparing this formula, which includes those of two equivalents of scolezite and one of natrolite, with the formula of Faröelite, that they differ in containing respectively three atoms of a monosilicate, and one atom of a sesquibasic silicate of alumina, combined with the same groups of elements: thus—

$$\left\{\begin{array}{ll} 2(CaO\,SiO_3 + Al_2O_3SiO_3 + 3HO & \text{scolezite} \\ \ \ NaO\,SiO_3 + Al_2O_3SiO_3 + 2HO & \text{natrolite} \end{array}\right\} =$$

$$\begin{array}{l} = NaO\,SiO_3,\ 2CaO\,SiO_3 + 3(Al_2O_3\,SiO_3) + 8HO \text{ mesolite} \\ \ \ \ NaO\,SiO_3,\ 2CaO\,SiO_3 + 3Al_2O_3\,SiO_3\ \ + 8HO \text{ faröelite.} \end{array}$$

And I am inclined to think that, in the case of minerals occurring in such intimate association as these, when there is a choice of formulæ equally according with the results of analysis, that one is preferable which shows some such simple relation, and therefore that Heddle's formula is more probably the correct expression for Faröelite, than that of a hydrous nepheline before mentioned.

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* By deficiency.

† Edin. New Phil. Journal, iii., p. 351.

‡ Fourth Supplement to Dana's Mineralogy, *loc. cit.*, p. 127.

Epistilbite.—I found this species somewhat constantly accompanying a very fine variety of stilbite on ledges of trap at Marionville, a village about 7 miles east from Port George. The stilbite was in large, transparent, colourless, broad, columnar aggregates, and the epistilbite in small, reddish coloured, rhombic crystals, nearly or quite opaque. Although the former is by far the more plentiful, the latter was present in considerable quantity in some specimens; and on few that I collected was it altogether wanting. Sometimes it appears to form the only lining in shallow cavities of the trap of this locality. A portion of the mineral detached from stilbite gave these results on analysis.—

Soda, . . .	0·99
Potash, . . .	0·99
Lime, . . .	7·00
Alumina, . . .	15·34
Peroxide of iron, . .	1·58
Silica, . . .	58·57
Water, . . .	15·42
	99·89

I met with the same substance in a specimen of honey-yellow stilbite in the cabinet of King's College, Windsor, Nova Scotia, among some minerals labelled "Nova Scotian;" but the precise locality of this one was not marked. In this case it was so intimately mixed with calc-spar as to render mechanical separation impossible. Its analysis, which follows, shows, on this account, some carbonate of lime;—

Soda,* . . .	2·02
Lime, . . .	9·53
Alumina,† . . .	16·10
Silica, . . .	56·13
Carbonic acid, . .	1·54
Water, . . .	14·36
	99·68

After deducting this accidental ingredient, the essentials are given below, and agree very well with the preceding, and also with those of an analysis of an Iceland epistilbite given by Kurlbaum:—

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* With a little KO. † With a little Fe_2O_3.

	How.	Kurlbaum.
Soda, . . .	2·10	2·05
Potash, . . .	...	0·19
Lime, . . .	7·87	7·81
Alumina, . . .	16·73	17·10
Peroxide of iron, . .	...	0·12
Silica, . . .	58·35	58·74
Water, . . .	14·93	14·21
	100·00	100·23

The formula for epistilbite given by Berzelius is—

$$(RO\ SiO_3 + Al_2O_3\ 3SiO_3) + 5HO,$$

and if RO = CaO, the corresponding per-centages are these—

CaO	Al_2O_3	SiO_3	HO	
9·17	16·78	59·32	14·73	= 100

The analyses recorded above would give for RO, $\frac{1}{4}$NaO + $\frac{3}{4}$CaO, leading to the formula—

$$NaO\ SiO_3,\ 3CaO\ SiO_3 + 4(Al_2O_3\ 3SiO_3) + 20HO,$$

which requires the per-centages—

NaO	CaO	Al_2O_3	SiO_3	HO
2·49	6·76	16·49	58·78	14·48 = 100.

Laumonite.—This mineral is very abundant at Port George; occasionally veins of three inches thickness are seen running down the sides of the cliff. A portion from the interior of a mass, gave these results, in the air-dry state—

CaO	Al_2O_3	SiO_3	HO	
12·07	21·64	57·43	15·26	= 100·44

which agree with the per-centages—

CaO	Al_2O_3	SiO_3	HO	
11·85	21·76	51·14	15·24	= 100

calculated from the usual formula—

$$3CaO,\ 2SiO_3 + 3(Al_2O_3\ 2SiO_3) + 12HO.$$

The crystals agreed in all respects with the descriptions given in the manuals. At Margaretville, laumonite occurs coloured green by copper.

Researches on Salicylic Acid. By ARCHIBALD S. COUPER.

Conflicting opinions being entertained among chemists respecting the constitution and basicity of salicylic acid, in order, if possible, to throw some additional light upon this question, I have been induced to undertake the investigation of the action of two equivalents of pentachloride of phosphorus upon the salicylate of methyl.

When these two bodies are brought into contact, the reaction which ensues is exceedingly violent, and it is necessary to add very gradually the one equivalent of oil of gaultheria to the two equivalents of perchloride of phosphorus. Vapour of hydrochloric acid, mingled with that of the chloride of methyl, is disengaged during the whole course of the operation.

The residue of this reaction is submitted to distillation. A trace of oxychloride passes over, and is followed by something approaching to an equivalent of the perchloride of phosphorus.

The temperature having now risen to about 160°, the residue has darkened in colour. Submitted to a further distillation, a colourless or slightly yellow liquid passes over, while the temperature rises rapidly to about 285° and 295° Cent. The portion passing between these temperatures is collected apart. It constitutes the larger part of the product of distillation. There remains a pitchy residue, which solidifies on cooling. The liquid collected, as described, on being submitted to analysis, furnished the following results:—

1. 0·41 grms. of substance gave 0·464 grms. of carbonic acid, and 0·0585 grms of water.
2. 0·49 grms. of substance gave 0·528 grms. of carbonic acid, and ·0705 grms. of water.
3. 0·515 grms. of substance gave 0·565 grms. carbonic acid, and 0·071 grms. of water.

1. 0·438 grms. of substance gave 0·7595 grms. of chloride of silver.
2. 0·34 grms. of substance gave 0·563 grms. of chloride of silver.

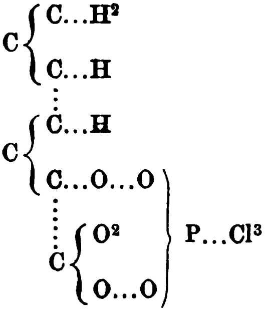
1. 0·651 grms. of substance gave 0·283 grms. of the pyrophosphate of magnesia.

These analysis lead to the crude formula,—

$$C^7 H^4 Cl^3 PO^6$$

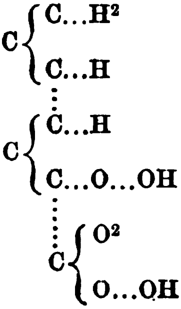
	Found.			Calculated.
	I.	II.	III.	
Carbon, .	30·86	29·4	29·9	30·65
Hydrogen, .	1·58	1·59	1·51	1·46
Chlorine .	41·01	41·05	...	38·86
Phosphorus,	12·2	...	...	11·5

According to the rational theory which I seek to develop in another paper,* the constitution of this body may be represented as,—



$$\left.\begin{array}{l} C\begin{cases} C\ldots H^2 \\ C\ldots H \end{cases} \\ \vdots \\ C\begin{cases} C\ldots H \\ C\ldots O\ldots O \end{cases} \\ \vdots \\ C\begin{cases} O^2 \\ O\ldots O \end{cases} \end{array}\right\} P\ldots Cl^3$$

It is a tertiary derivative; the secondary derivative, salicylic acid, being,



$$\begin{array}{l} C\begin{cases} C\ldots H^2 \\ C\ldots H \end{cases} \\ \vdots \\ C\begin{cases} C\ldots H \\ C\ldots O\ldots OH \end{cases} \\ \vdots \\ C\begin{cases} O^2 \\ O\ldots OH \end{cases} \end{array}$$

The reaction of which this body is the result, is represented by the following equation :—

$$C^7 H^6 O^6 + P Cl^5 - 2HCl = C^7 H^4 Cl^3 PO^6.$$

This is the same body which, unpurified, Gerhardt calls the chloride of salicyl,† and Chiozza the chloride of chlorobenzoïl,‡ or the hydrochlorate of monochlorobenzoic acid. In order to determine rigorously whether the body produced by Chiozza from salicylic acid was really the same as that which Gerhardt and I have obtained from the oil of gaultheria, I investigated the action of the perchloride of phosphorus upon the pure acid. The reaction which takes place between the two solid bodies is less violent than when the oil was employed. Nevertheless, in this instance also the action is prompt. After the vapour of hydrochloric acid has passed off, the residue in the flask is identical with that which remains when the oil of gaultheria is employed. These two products distil in identically the same manner, with the same physical appearances, while the products of distillation produce exactly the same results upon analysis.

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* Lond. Phil. Mag., August 1858.

† Compt. Rend. de l'Acad. xxxviii. 34.

‡ Ann. de Chim. et de Phys. [3] xxxvi. 102.

These products display also entirely the same results in all their reactions.

The terchlorophosphate of salicyl obtained by either process is very soon decomposed by water in the cold, and immediately, upon the application of heat, the products being hydrochloric, phosphoric, and salicylic acids.

Chiozza's monochlorobenzoic acid, which he believes to be produced along with hydrochloric acid in the decomposition of this body, is only salicylic acid rendered impure by hydrochloric and phosphoric acids.

Chiozza did not succeed in producing the reaction for salicylic acid by the perchloride of iron. Nor is it to be observed till the liquid containing the phosphoric acid is separated from the crystals of salicylic acid, but as soon as this is done, the application of the test gives the intense and characteristic colour produced by the acid in question. An analysis which I have made confirms this result.

0·301 grms. of these crystals, expressed between folds of bibulous paper, re-crystalized from water, and dried, upon combustion, gave 0·668 grms. of carbonic acid, and 0·116 grms. of water.

	Found.	Calculated.
Carbon, . . .	60·52	60·86
Hydrogen, . . .	4·27	4·34

In another analysis 0·2205 grms. of substance gave 0·4885 grms. of carbonic acid, and 0 0875 grms. of water, which, calculated, gives,—

60·42°/₀ for carbon, and 4·4°/₀ for hydrogen.

This acid agrees also in all its physical aspects with the salicylic acid.

It is evident, then, that those three bodies,—namely, the chloride of salicyl of Gerhardt, the chloride of chlorobenzoil, and the chlorobenzoilic acid of Chiozza, are not yet known.

When the terchlorophosphate of salicyl is quickly distilled, hydrochloric acid is given off in considerable quantity, while the body, at the same time, acquires a dark colour. The last portion of the product of this distillation, which passes at a temperature above 300° Cent., being allowed to stand for a day or two in a closed tube, deposits large crystals, which having been pressed between folds of bibulous paper, and submitted to analysis, gave the following results:—

1°. 0·3565 grms. of substance gave 0·5255 carbonic acid, and 0·074 grms. water.

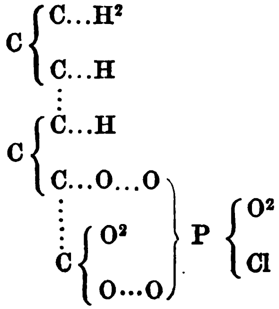
2°. 0·57 grms. of substance gave 0·826 grms. carbonic acid, and 0·101 grms. of water.

1°. 0·255 grms. of substance gave 0·176 grms. of chloride of silver.

Compared with the crude formula $C^7 H^4 O^8 ClP$, these results will be:—

	Found.		Calculated.
	I.	II.	
Carbon, .	40·2	39·16	38·44
Hydrogen,	2·3	1·96	1·83
Chlorine, .	17·07		16·25

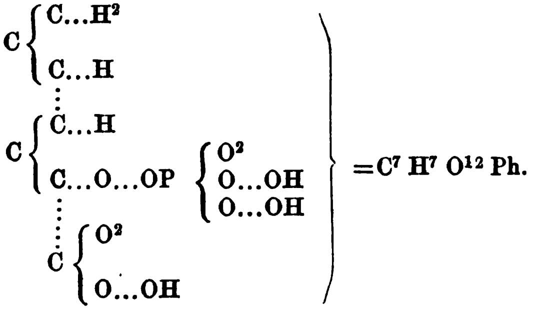
The rational formula is,—



The monochlorophosphate of salicyl being a body which is quickly decomposed by exposure to the air, and only to be obtained from a liquid passing at an exceedingly high temperature, I did not think it easily possible to obtain a purer body, and have contented myself with the above analysis. Although these analyses might in themselves leave some doubt as to the composition of the body, still, when taken in connection with a combinate which I am about to describe, and which is produced from the monochlorophosphate of salicyl, as well as from the terchlorophosphate, I think I may be warranted in ascribing definitely to it the above formula.

This compound is produced by the exposure to the atmosphere of the bodies just mentioned. The chlorine contained in them decomposes the water of the atmosphere combining with an equivalent of hydrogen, while the oxygen is taken up by the bodies in question in replacement of the chlorine. This new oxygen, however, enters into the state in which it is found in acids, and has a great affinity for the oxygen of water and bases. It therefore attracts the water of the atmosphere, and the combinate becomes an hydrated acid.

This body being submitted to analysis, gave results according with the rational formula:—



$$\left.\begin{array}{l} C\left\{\begin{array}{l} C\ldots H^2 \\ C\ldots H \end{array}\right. \\ \vdots \\ C\left\{\begin{array}{l} C\ldots H \\ C\ldots O\ldots OP \left\{\begin{array}{l} O^2 \\ O\ldots OH \\ O\ldots OH \end{array}\right. \end{array}\right. \\ \vdots \\ C\left\{\begin{array}{l} O^2 \\ O\ldots OH \end{array}\right. \end{array}\right\} = C^7\,H^7\,O^{12}\,Ph.$$

1°. 0·2845 grms. of substance gave 0·397 grms. of carbonic acid, and 0·086 grms. of water.

0·1785 grms. of substance gave 0·103 grms. of the pyrophosphate of magnesia.

	Found.	Calculated.
Carbon, . . .	38·05	38·53
Hydrogen, . .	3·39	3·21
Phosphorus, . .	14·48	14·22

This phosphosalicylic acid is a tribasic acid, and forms insoluble salts with baryta, lead, and silver, containing three equivalents of these metals.

I propose taking into consideration more fully the constitution of salicylic acid in a subsequent communication. The formula here given of that body may be in the meanwhile suggestive.

On the Structure of Mont Blanc. By Dr H. de Hallwyl.

In the year 1855, the late Dr Sharpe, after having spent eight days in the neighbourhood of Mont Blanc, attempted to prove the falseness of the theory which the most able geologists had hitherto propounded concerning the structure and origin of the central Plutonic masses of the Alps. According to his views, the system of the arches of foliation, having their axes parallel to each other, and by the observation of which he hoped to elucidate the features of North Wales and of the southern districts of Scotland, is to be found on a line traced from Villeneuve to Aosta. In this district he believes that the arches are so strikingly exhibited as to convince any sound natural philosopher of the truth of his theory concerning them. The matter received the attention of several men of science, among whom Professor James Forbes successfully and ably refuted the arguments of his countryman.* In the following pages it has been my endeavour to afford some further information on the subject.

The chain of Mont Blanc presents outlines quite peculiar to itself. We neither observe any huge rounded back of schistose rocks, nor any system of mountain ridges diverging from culminating points; but rather there is seen a steep symmetrical central mass, adorned with many bold pinnacles, and forming an independent part of the wall whose battlements overlook the fertile valleys of the Po and of its upper tributaries.

The Neptunian formations appear to the north and to the south of the chain of Mont Blanc, as well as in the valleys of Ferrex, Lex Blanche, Montjoie, and Chamounix. They are overhung by the feldspathic rocks of the Aiguilles Rouges on the north, and of Mont Chétif and Mont de la Saxe on the southern side of the chain. The most important sedimentary accumulations are to be found on opposite sides of the centre of the crystalline mass; that is to say, in the Mont Lacha, where, at the junction of Val Chamounix and Val Montjoie, the Arve turns its course to the right, and in Mont Frėty, in the very front of the narrow and tortuous chasm by which the Dora Baltea makes its southward escape.

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* Edin. Phil. Journal, April 1856.

Let me speak first of the formations which are laid open in the valleys, as they are of an earlier date and first accessible to the geologist.

NEPTUNIAN FORMATIONS.

From Col de Ferrex to the Glacier of Miage.—Along this whole tract the bottom of the valley is covered with fir trees, shrubs, small herbs, and many stony fragments of various dimensions. The bare sedimentary rock appears only in scarce spots among the pasture grounds and forests of Mont Cramont and Mont Carmet, and in some parts of the western wall, where the spring waters have uncovered it in deep ravines. The portion which runs along the foot of the main chain consists of alternating dark clay-slates and yellowish grits, both of which contain lime and silica in a ratio of five to two.* Sometimes you may observe thin layers of quartz, or of carbonate of lime, parallel to the bedding, or branching off in veins. A large bed of quartz of this description was found by De Saussure near Mont Ru, and by Sharpe† at Col Ferrex, where it dips between the crystalline rock and a conformable series of dark slates, at an inclination of 60° to 70° E.N.E. Beneath the glacier of Triolet the strike bends to the west, until to the difference of about 30° near Entrèves. To the north of Mont Frėty the slates strike N. 35°–40° E., but to the south the direction is gradually changed to N. 5° E., and even N. 5° W.

Moreover, if we proceed downwards through the Val Ferrex, the dip becomes westerly. To understand this it is only necessary to ascend the Croix de la Bernada, not far from Courmaiyeur, and from this elevated position to survey the lower parts of the main chain. Everywhere the bedding of the clay-slates may be known by light-coloured insertions of limestone and grit. Such, for instance, is evidently the case in the fourth ravine to the north of Mont Frėty. In the second ravine the rocks below are very dark, and cleave easily into thin layers; they dip 46° to 72° N.W. The upper ones are rather dense, rough, light, and contain more of lime; they dip 50° N.W. The sketch (fig. 1) shows the front view of this ravine. I could not succeed in reaching the limit between B and C. C and D, however, seem to dip westward.

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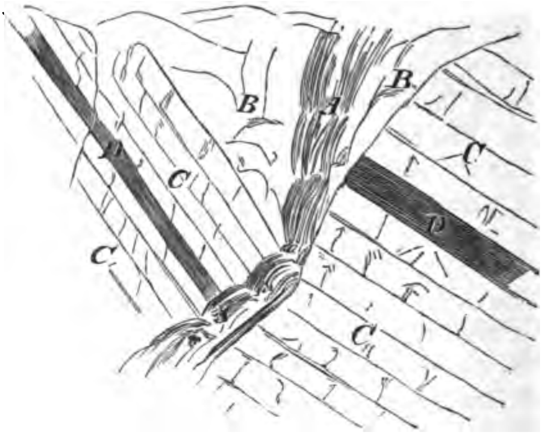
* De Saussure, Voyages dans les Alpes, T. III.

† Quarterly Journal, 1856.

Fig. 1.



A Waterfall—*B* Rounded gneiss rocks—*C* Light coarse strata—*D* Dark slates.

On the steep front, as well as on the northern side of Mont Fréty, De Saussure thought the angle of the dip to be about 35° to 47° N.W. At the foot of Mont Fréty, opposite to the foremost part of the glacier of Brenva, I found the slates dipping 45°, and on another spot only 10°; though the latter observation might scarcely be of any importance. I observed the joints which De Saussure mentions as dipping 50° S.E. to be interruptedly and faintly developed in the vicinity of Entrèves. In this neighbourhood, on the very lowest part of Mont Fréty, the beds of the slate are bent with their concavity towards the valley in such a manner that a vertical line would cut them twice. A similar flexure (fig. 2) was observed by Forbes* at the issue of the great ravine between Mont Fréty and the glacier of Brenva. He found the angle of the dip to vary from 38° to 50°. From more extended observations I ascertained the arch to vary in its angle from 35° to 60°. Higher up, on the opposite bank of the same ravine, micaceous clay-slate, having

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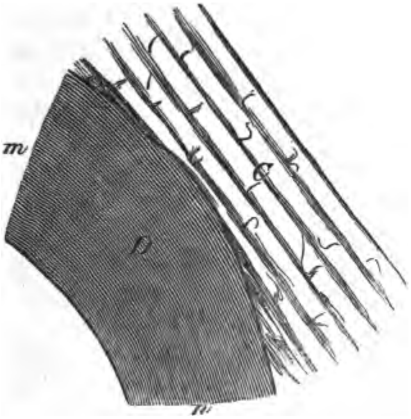
* Travels through the Alps of Savoy.

Fig. 2.



a thin cleavage, and with its upper parts hanging over, leans against the crystalline rock. At its further extremity the ravine is enlarged and much broken, exhibiting in the middle a huge mass of dark coarse siliceous limestone, with indistinct bedding and traces of a cleavage dipping N.W. The plane of separation between this limestone and the protogine dips 75° to 80° N.W., and the former is traversed by numerous quartz veins. This mass seems to have more powerfully resisted the eruption of the Plutonic rock than the surrounding softer slate.

On the opposite side of the valley the strike is north-eastern. On the Grand Ferrex the beds dipping westward form a synclinal system with those of the Petit Ferrex. Towards Courmayeur they assume a vertical position; they then dip eastward, and from this point, in connection with the beds dipping under the main chain of Mont Blanc, the geologist is enabled to arrange them symmetrically around a rectilinear anticlinal axis running from Pré Sec in Val Ferrex to the glacier of Miage (fig. 3). On the green edge of Mont Carmet, which looks down upon Val Ferrex, the beds strike N. (62° to 75°) E., and dip 75° W. to 80° E. To the south of the spot where the feldspathic rocks composing the right bank of the Trou des Romains make their first appearance, the dip becomes decidedly eastern; so much so, that on both sides of the Dora, in the Montagne de la Saxe and in Mont Chétif, the igneous rocks rest entirely upon the sedimentary formations. As we descend from the Croix de la Bernada towards Entrèves, the strike may be observed to change its direction, N. 45° E., N. 30° E., N. 25° E. On the edge of both formations it is N. 28° E.; close to the chapel Notre Dame, N. 32° E. On this side of the valley, also, the sedimentary rock consists of dark slates, sometimes micaceous, and alternating with limestones and grits, showing a prismatic cleavage. Where in contact with the igneous rock, the slates are hardened, and some few inches inward, appear coarse, and contain quartz. All these observations, generally speaking, apply with equal force to Mont Chétif.

Fig. 3.

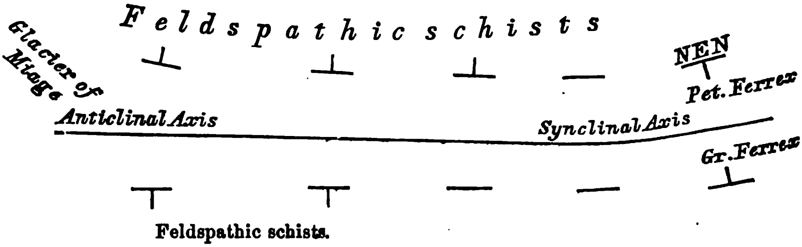
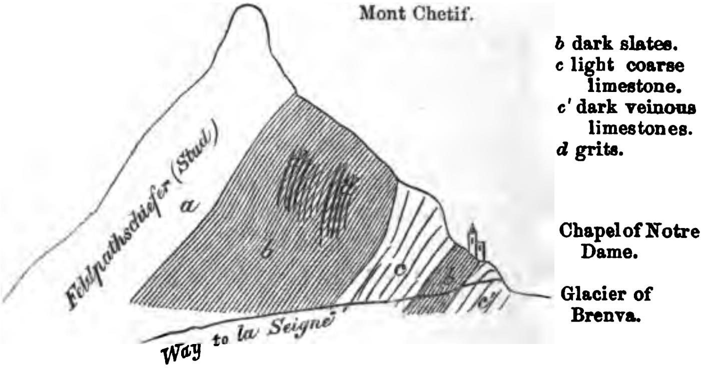


Fig. 4.



Between the glacier of Brenva and that of Miage the foot of the crystalline rock is covered by debris accumulated in the valley; but on the opposite bank, wherever the Neptunian slates are seen, they dip eastward, often with low angles and disturbed bedding. Where the river is deflected by the frontal Moraine of the Glacier du Miage, are exposed dark veined slates, overhung by yellowish limestone, which is replaced further up by a tract of coarse white gypsum.

Throughout the district just described I was unable to make out the slightest trace of any transversal cleavage. However, the slates cleave in the direction of their bedding, and the coarse specimens among them usually exhibit a system of joints perpendicular to the bedding.* But I quite fail to comprehend Sharpe's description of a cleavage crossing the beds of the east side of Val Ferrex at an angle of about 30°.

The Passes of La Seigne and Bonhomme.—All observations which have hitherto been made in the neighbourhood of these spots lead to the conclusion, that the sedimentary rest upon the Plutonic rocks in undisturbed order. Some pyramids of light coarse limestone, which seems to have been exposed to subterranean agents, appear in the Lex Blanche and above Nant Bourant, either touching the hornblendic schists, which also contain quartz and mica, and form this part of the main chain, or separated from them by grits. In the former of these localities I found some indistinct beds dipping 60° S.E., but no trace of the bed of conglomerate mentioned by Sharpe as dipping only 20° S.E. What he took for a vertical cleavage I rather believe to be jointage, as the rock splits vertically into huge table-like pieces, but does not exhibit the slightest fissile structure in that direction. On these limestones rests the whole series of micaceous and quartzose grits and clay-slates, alternating with limestone breccia, whose section is revealed in the Col de la Seigne (fig. 5). The strike is of about 40° N.E. The quartzose mica schists about Motet, as well as the compact limestones parallel with them, both of which formations have been noticed by De Saussure, seemed to me to be the continuations of the strata marked *c* in the diagram. Beneath Motet, I observed on the path a great many blocks of a greenish verrucano, which had descended from the right.

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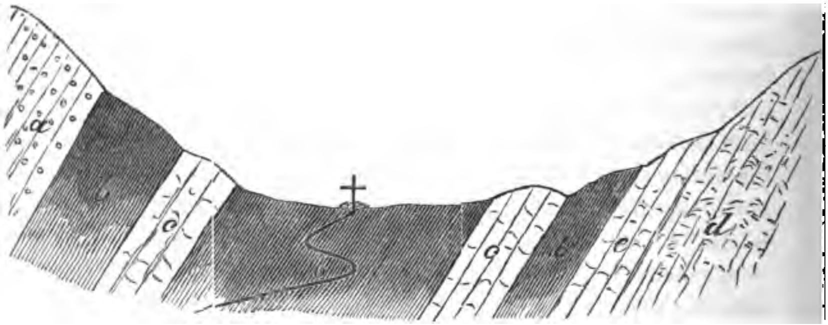
* Similar relations occur in the Harz, where greywacke grits are embedded in the slates of Wissenbach.

Fig. 5.



a Limestone brecchia (blocks of the Lake Combal).—*b* Glittering dark slates.—*c* Yellowish and gray grits.—*d* Crystalline schists of the central mass.

The slates of the Bonhomme represent an anticlinal ridge. The dark clay-slates above Chapiù dip 48° S., and nearer to the top, 28° S. They strike as we proceed upwards, N. 55° E. and N. 40 E. Close to the last chalet, they strike N., and dip 40° E. On the top, the quartzose grits are most abundant. The bedding is very disturbed, and the angles of the dip are in general exceedingly low. On the side of Nant Bourant, the beds strike N. 45° E. Some slaty chloritic grits, imbedded in the dark clay-slates, dip 60° N.W. The sedimentary rocks, however, do not seem to rest for any considerable distance on the western declivity of the crystalline mass of Mont Blanc; for, on the left side of the valley of Bionassay, the dark slates of the Vorazzé, striking N. 33° E., dip with an angle of 55° to 70° towards the central chain.

Chamounix—From the Mount Lacha to the Col de Balme.—The Neptunian formations of this district are still more obscure than those above described. They exhibit similar appearances in their relative position to the Plutonian masses. Near the Chalet la Blaitière, above Prieuré, De Saussure* and Necker† have seen the limestone dipping under the crystalline rocks of the Aiguille de Blaitière. Professor J. Forbes‡ and

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* Voyages, T. II. † Memoir on Valorsine in Geneva Transactions.

‡ Ed. N. Phil. J. 1856.

Favre observed the same on the way to the Chapeau. According to Favre, the dip, where the two formations touch each other, is 30° E.; I found it to be 45°; while the beds strike N. 15° W. to N. 60° E. The stratification is indicated by alternating beds of light, coarse, and dark slates peeling off in thin flakes parallel with the bedding.* The dark slates, together with grits and limestones of a rather coarse and micaceous kind, whose bedding may be seen in many deep and broken ravines, form the Mont Lacha and the Col de Voza. On the northern declivity of this crest, the slates strike N. 30° W., N. 15° W., or even due N.; on the crest itself, N. 20° E. to N. 65° E., and are therefore parallel with the Val Chamounix and the main chain, whose strike is nearly N. 45° E. The dip is thoroughly easterly. Proceeding from the Pavillon Bellevue towards the Aiguille du Gouté, I found the angles 46°, 48°, 50°, 55°; further down, towards Bionassay, 35° and 40°. On the north side of Mont Lacha, the angles of the dip seem in like manner to increase in proportion to the heights of the points of observation, 44°, 50°, 62°. The strike is N. (40° to 45°) E.; further below, N. 35° E. These considerations seem to suggest that the uplifting and pressing force is not merely to be looked for as having acted from below and from the west. Close to the summit of Mont Lacha, the gneiss of the Aiguille du Gouté lies in contact with the dark slates, which dip 70° E.; and if we imagine a vertical plane to be drawn to the bottom from this spot, it would intersect, as far as visible, the Neptunian formations. However, I did not see the dark slates of Mont Lacha dipping below the igneous rock at any point of contact. The stratification of the district I have just described is easily understood. It is marked by the various differences in colour, density, coarseness, and cleavage, and by the prominent extremities of the beds, which look westward wherever they are laid open by the agencies of water and earth-slips. In the upper region of the Gria ravine, I was fortunate in finding two strata of a black, glittering, and friable anthracite, imbedded between dark clay-slates and micaceous limestones, dipping 44° E., and striking N. 35° E.

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* Jukes (Excurs. in Newfoundland) observed the same to be the case as to many layers of greywacke grits imbedded in clay-slates.

The upper bed has a thickness of two or three feet, and the lower of about four.

Besides the cleavage, which I found to be throughout parallel to the bedding, I observed in various spots a second set of divisional planes, crossing the first, and forming smaller angles with the plane of the horizon. Between the Col de Forclaz and the Pavillon Bellevue the angle formed by the two sets is about 40°, and at Mont Lacha about 25°. Both strike in the same direction. The second may rather be regarded as a mere system of joints, for it is a fact that joints also very often exhibit a parallel structure. But I am at a loss to understand how Major Charters,* having his mind imbued with Sharpe's ideas, could speak of the slates of Mont Lacha as if their bedding dipped 70° W. and their cleavage 20° E.

On the Col de Balme, again, the grits and dark slates are found in large masses. Above Le Tour they dip eastward, and on the top, near the inn, in a vertical direction. Further to the west, near Valorsine, an anticlinal axis strikes parallel with the valley of Chamounix. Favre† found the same rocks below the Croix de la Flegère dipping abruptly to the S.E., leaning against the igneous mass of the Aiguilles Rouges, but assuming a horizontal position on the top of that chain, where they contain belemnites, ammonites, and encrinites. The transition between the Neptunian and the Plutonic formations is made on this point by anthracite slates, and by the pudding-stones of Valorsine.

The light quartzose crystalline limestones, which, as already mentioned, are to be found in the Val d'Entrèves, on the Col de Seigne and Col du Bonhomme, appear again in the Val Montjoie and in the Val Chamounix. I noticed, as a specimen of them, some round-shaped rocks dipping towards the main chain at the foremost end of the glacier of Bionassay. De Saussure speaks of them as forming the hill called Côte du Piget near the Source de l'Arveiron, and dipping 50° E. Above Trient they rise in bold peaks. Between L'Argentière and Tours, near Biolay, and in the ravine of the Gria, there appear strata of calc tuff and splendid white gypsum, dipping beneath the gneiss at its approaching to the dark slates. Particularly on the latter of the above spots, I observed such a mode of stratification, where the angle of the strike changes occasionally to N. 15° W., while that of the dip is 40° E.

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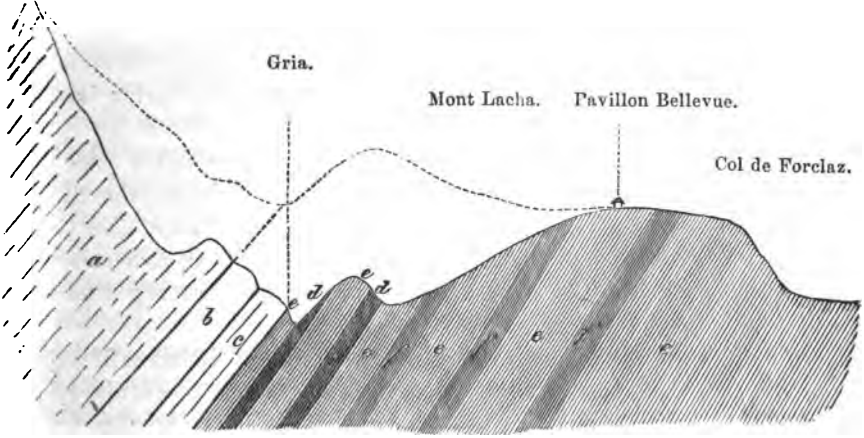
* Quart. Jour. 1856.

† Bull. de l'Soc. Geol. S. Fr., 2de ser., t. v.

Fig. 6.

Declivity of the Aiguille du Gouté.



a Crystalline schists.—*b* Gypsum and tufas.—*e* and *f* Dark slates and grits.—*c* Solid limestones.—*d* Anthracite.

It is no longer matter for discussion, whether these layers of tufa and gypsum, which in various other places appear in the neighbourhood of erupted chains, are to be considered as aqueous deposits, or as metamorphic transformations of limestones. For, though Murchison,* who is an authority on this subject, seems to favour the igneous theory, imagining that the transformation might have taken place at the same time as the uplifting of the main crystalline chain of Mont Blanc, it appears to me that there are many strong arguments which militate against such an opinion. For instance, it is mentioned by Sharpe that the mass of gypsum near the foremost part of the glacier of Taconuay must have originated at two different periods, the older part showing traces of a cleavage dipping 70° S.E., and talc exudations on the divisional planes, the latter being denser and purer. He believes them both to be of aqueous formation. So did De Saussure, who found huge blocks of granite imbedded in the calc tuff of the Val Chamounix; and Favre, who detected beds of tufa lying in the region of contact between the protogine and the crystalline schists in the neighbourhood of the glacier of Trient.

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* On the Structure of the Alps.

THE PLUTONIC FORMATIONS.

The main crystalline chain of Mont Blanc, varying in breadth from six to nine miles, and nearly thirty-five miles long, extends S.W. to N.E. from the Col des Fours to the foot of the Dent de Morcles, like the segment of a circle, having its centre far in the West.

The predominating rock is that which Jurine called protogine. It consists of glassy quartz, twin crystals of orthose, opaque oligoclas, hexagonal tablets of potash, mica, and small bent pearl-coloured laminæ of talc. The latter two minerals are often intimately connected with each other, forming thus Jurine's dolerine.

The rocks lying in the medial line of the main chain are of a coarse crystalline character, sometimes very like true granite; while on both sides the thin layers of mica and talc impart to them a foliated structure. Above the glacier of Miage, De Saussure observed a syenitic rock, which, as Studer has shown, is transformed into arkesine, by mingling with quartz, steatite, chlorite, and crystals of sphenite. It is known that the arkesine predominates in the Alps between the Grand St Bernard and the Theodul Pass.

The protogine in the axis of the main chain is traversed in its longitudinal direction by large joints diverging very little towards the top; the tables which they form, exhibiting sharp edges and bold points, have been compared by De Saussure to the leaves of an artichoke.

The limit between the solid mass of the protogine and its foliated varieties nearly coincides with that of the area on which stand the *Aiguilles*, so characteristic of the mountain-group of Mont Blanc. This limit extends closer on the eastern than on the western side to the Neptunian formations; but it may be very distinctly traced, for De Saussure mentions that he has detected some regular strata of protogine imbedded in the adjoining crystalline schists. Favre observed such a threefold alternation above the edge of the glacier of Trient; and both geologists believed that the same might likely be observed on the whole west side of the Mont Blanc chain.

The foliation of the crystalline schists, if spoken of in regard to its large extension, undulates little, if at all; but when examined on a smaller scale, it frequently exhibits the foliating layers disposed in waving lines, which, being exposed in transverse sections, induced De Saussure to call this rock *granit veiné*. The higher we rise above the valley, the steeper becomes the dip of the foliation: it appears fan-shaped, converging towards the centre of the chain. Ascending to the Montenvert, I found the dipping angle of the crystalline schists to be 35°, then 55°; near the Chapeau, 62°; on the edge of the Mer de Glace, close to the pavillon, 70°; and at the foot of the Aiguille du Dru, 75° S.E. At the same time, the gradual transformation of the schists into true gneiss may be readily observed. Respecting the divisional planes of foliation, a superficial observer might easily be deceived; for there appears another set of cleavage planes, somewhat bent towards the exterior, and crossing the true foliation near the Chapeau at an angle of 60°. This second divisional system may have originated from isothermal planes.

Both sides of the crystalline mass of Mont Blanc rest on the adjoining Neptunian rocks, so that the planes of foliation on one side, of cleavage and bedding on the other, all running nearly parallel to each other, and to the axis of the main chain, form together a great fan, opened at the top. De Saussure first observed this extraordinary fact near Mont Broglia; and Sismonda[*] above Pré Sec, in the Val Ferrex.

Above the pavillon of Mont Fréty, the common surface between the crystalline schists and the protogine dips 60° to the W. According to Sharpe, the same angle belongs to the planes of foliation of the crystalline schists. Mount Fréty seems to be composed of gneiss; until very near the edge on which the pavillon stands, it is covered with erratic blocks of protogine. The limit between this gneiss and the dark slates is not to be seen on Mount Fréty, being covered with vegetation; but a little farther to the south the inversion and bending of the former, and the abnormal overhanging of the latter, is well exposed. In viewing this locality, the idea naturally occurred to me, that the crystalline rock has been pulled outwards like a huge tenacious wave; and this appeared even more evident, when I perceived a coarse crystalline mass of gneiss-granite, which, separated from its main rock, is resting on the limestone, as if it had overflowed, and hardened during cooling.

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[*] Mem dell' Acad. de Sc. de Torino, 2 ser., t. iii.

As regards the extent of metamorphic action which has taken place on the line of contact between the crystalline and the Neptunian rocks, De Saussure informs us, that in the Val d'Entrèves it is included within a small zone, and easily distinguished in four gradual stages. According to Favre, it is indicated on the side of Chamounix by a thin layer of kaoline towards the gneiss, and towards the dark slates by a layer of magnesian limestone.

The two primordial masses of Mont Chétif and Montagne de la Saxe appear to the traveller coming up from Aosta like two gigantic pillars on the sides of a majestic stage, the background of which is represented by the abrupt wall of the Col du Gèant. The petrographic and stratigraphic relations of Mont de la Saxe are best understood if, starting from La Saxe, we rise over the western declivity of the Trou des Romains to the Croix de la Bernada. On the inferior spots the rocks are abundant in mica and talc, and exhibit a distinct foliation. The same is the case where, on the west, they rest upon the Neptunian slates; but close to La Saxe, in the centre as well as on the top of the mass, we find larger crystals of feldspar, predominating quartz, and a rather obscure foliation. The limit between this eruptive mass and the dark slates runs parallel with the cleavage planes of the latter. When followed from N.E. to S.W., it will be found to change its dip from the W. to the E. The foliation in this line strikes N. 70° E. to N. 20° E.; even on a single spot—that is, at the northern end of the feldspathic mass,—N. 10° W. The detailed relations of Mont Chétif are unknown to me. Both the eruptive masses, generally speaking, appear, according to

Studer, like a stratum of feldspathic rock, about 200 feet thick, imbedded in the sedimentary schists with a steep eastern dip.

The central mass of the Aiguilles Rouges, about twenty-six miles long and three to five miles broad, extends on the west side of the main chain of Mont Blanc, and parallel to it from Servoz to the Dent de Morcles. Here also the protogine nucleus is at once apparent in the outlines of the scenery. Above the rounded steep wall of gneiss and *granit veiné* which composes the main body of the chain it rises in a series of abrupt and partly inacessible pinnacles. The crystalline schists have been observed to be the most extensive in the west between the Aiguilles Rouges and the Buet, as well as in the north, downwards to the valley of the Rhone. On the right bank of this river they have been changed into red porphyry; in Valorsine, into a widely-spread greenish mass of hornstone; which has been again metamorphosed into Verruccano and anthracite slates. Near Berberine, close by the path of the Tête-noire, a true alpine granite without talc breaks into the *roche de corne,* changing it partially into a solid gneiss, or spreading through it in fissures, or as eurite in minute veins. Fournet* satisfactorily explained these appearances. Near Servoz, the River Arve has uncovered a reddish granite, which Sharpe took for granted to be trap. He describes the mass as having been tilted up like an arch, its foliation showing a concentric disposition, and that of the surrounding crystalline schists having been completely disturbed.

Also in the protogine of the Aiguilles Rouges there may be observed a perpendicular set of divisional planes striking N.E., and parallel to the foliation of the adjoining gneiss and veined granite. A transverse section would represent a steep anticlinum. The Neptunian schists of this district rest on the primordial formations under high angles.

CONCLUSION.

Notwithstanding his repeated inquiries in the neighbourhood of Mont Blanc, and his first-rate merit in laying the foundation to the alpine geology, De Saussure was not successful in explaining the origin of the mountain district which has been treated of in this paper. Probably his mind was imbued with Wernerian doctrines, and therefore occasionally he compared the main chain of Mont Blanc with its various sharp-edged pinnacles to an immense crystal. However, I was no less surprised to see that Favre,[*] a man of as great scientific skill as knowledge, in publishing his most interesting discoveries on the Aiguilles Rouges, uttered the opinion, that the uplifting of the main chain of Mont Blanc had not influenced the position of the sedimentary strata in the valley of Chamounix. Rogers,[†] too, seems to have been wrong in applying his Appallachian theory of the undulations of the earth's crust to the interpretation of the Mont Blanc district. But at first sight a superficial observer may imagine that he has detected some data for its support. Such are the repetition of similar strata in a transverse section, the accidental lowering of the angles of the dip as we proceed from the Croix de la Flegère towards the Glacier des Bois, finally the cleavage being parallel with the supposed axial planes of the curvatures of the bedding; but, if further looked into, these appearances will be found unavailing to the above theory, the more so as they have no analogy on the eastern flanks of the Mont Blanc chain. Even though an enthusiastic follower of Rogers should maintain the whole Neptunian series in the valley of Chamounix to be a single wave, the explanation would prove unsatisfactory.

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* Suite des Recherches sur la Géol. de Alpes.

Neither is the theory of Sharpe, as to the vaulted arches, compatible with the phenomena observed. According to Sharpe, two vertical planes of foliation, separated about two miles from each other near the glacier of Tacul, and thence diverging a little southwards and northwards, run along both sides of the axial plane of the Mont Blanc chain. The planes of foliation, forming a steep anticlinum between these two axes, expand on their exterior sides like a fan; thus, supposing them to join the foliation planes of the Montagne de la Saxe and of the Aiguilles Rouges, they would complete gigantic arched vaults above each of the valleys of Chamounix and Entrèves. These vaults, Sharpe continues, are bounded by others similarly formed and running on parallel to them, every one being separated from its neighbour by a plane of vertical foliation. Sharpe carefully follows out these divisional planes throughout the Plutonian as well as the Neptunian formations, namely, as foliation in the former, and as cleavage in the latter. Thus, for example, he fancies that he discovered the western main plane of vertical foliation in the cleavage of the jurassic rocks of the Col du Bonhomme, the eastern one in that of the clay-slates of Mont Catogne near Sembranchier, and of the limestones of the Lex Blanche and of the Col de la Seigne. The perpendicular plane of foliation of the Aiguilles Rouges is said by him to strike to the west of the Col de Balme, and to show itself again in the precipitous gneiss rocks on the edge of which the traveller ascends from Trient to the small station of the Col de Forclaz. Our geologist, too bold in his speculations, has gone even so far as to divide the whole area between St Maurice and Aosta into nine contiguous semicylindrical arches, having their axis running N.E., in which case the two largest of them ought to have overhung the valleys on the sides of the Mont Blanc. He admits, however, that the bedding is not in keeping with those arched divisional planes, even that the whole Neptunian series between the Val Ferrex and Livrogne, including the anthracite and the inferior oolite, dips conformably S.E.

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[*] Bull. de l'Soc. Geol. de Fr., 2 ser. t. v.

[†] Trans. of the Royal Soc. of Edinburgh, vol. xxi.

If thoroughly examined, there will scarcely be found any mountainous district less adapted to the above theory than this which has been just treated of. In the first place, I cannot understand why the limits of the supposed arches should, in any case, be represented by a plane of vertical foliation running along a ridge of mountains, and why it should not rather be occasionally indicated by a synclinal valley? Moreover, we would ask why, no arch being complete, nor even nearly so, there are no traces of any important Plutonic eruptions or faults on the lines of the supposed cylindrical axis? To give effective support to Sharpe's theory, it would be necessary to conceive extraordinary sinkings of ground, or, combined with these sinkings, we must admit of the erosive power of fictitious oceans. The supposed existence of such waters, however, would only involve in new difficulties. For, should we adopt the opinion of Sharpe,* to the effect that the Val Chamounix and the chasm occupied by the Mer de Glace had been excavated and moulded by the waves of the sea, how are we to explain the want, in these spots, of any marine deposits of a more recent date than the Neptunian formations, which have been affected and tilted up by the elevation of the Mont Blanc chain. Even the detritus which has filled up the bottom of the above-mentioned valleys, and of those adjoining, is thoroughly the same that is daily carried down from the firm rock by streams of water and of ice.

But the main point to be ascertained is intimately connected with the question whether the deposition of the Neptunian formations in the region of Mont Blanc must be supposed to have taken place before or after the eruption and disruption of the Plutonic central masses? It is evident that if the sedimentary slates really dip under the crystalline rock, it follows, that the latter must needs be of a more recent origin; and if so, the Sharpeian theory falls to the ground at once. Therefore he culls out such sentences of De Saussure's works as seem to suit his purpose, and disputes the soundness of Studer's and Forbes's observations. For these reasons, and also as having witnessed myself what I consider to be the strongest confirmation of the views of the Alpine geologists, I deem it unnecessary to proceed further in confutation of the theory of the arches.

The best way, after all, of elucidating the origin and actual structure of the chain of Mont Blanc seems to me to be that adopted by Necker, Forbes, and Studer, whose opinions are supported by many careful observations. These maintain that each of the central crystalline masses made its outbreak in a tenacious semifluid state through a longitudinal rent, lifting up the sedimentary crust, and overturning it where its moving subterranean power was greatest. Therefore it is that the igneous rock rests on the Neptunian in the centre, and that it supports the sedimentary formations on the extremities of the Mont Blanc chain. As to the foliation, it may have originated in the manner which was first indicated by

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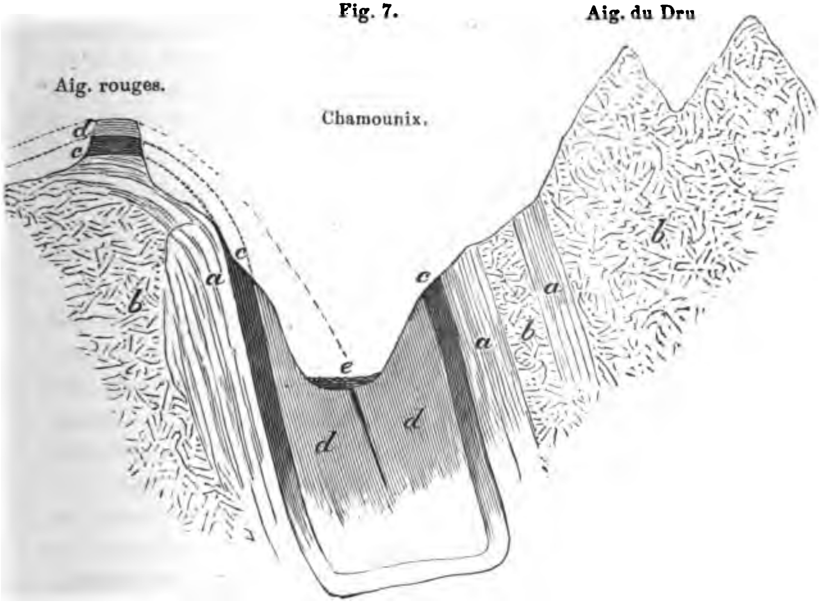
* Quarterly Journal, 1856.

Fournet, thus: Conceive a stony mass in the above state, and being impregnated with thin mineral folia, pressed from below through a narrow fissure. On account of the movement, the friction and the tension or pressure exerted on the mass by the walls of the rent, all the movable layers would assume the same vertical position, and expand towards both sides as soon as the resisting sediments gave way. Such seems to be the origin of the undulated planes of foliation, and of the fan-like structure it most generally exhibits everywhere in huge chains of crystalline schists. Moreover, the metamorphism and cleavage of the adjoining Neptunian formations may principally have been occasioned by the pressure and the heat proceeding outward from the axis of the elevation.

The idea, finally, which I have got of the stratigraphic relations of the Mont Blanc district, may be illustrated by the two following diagrams.

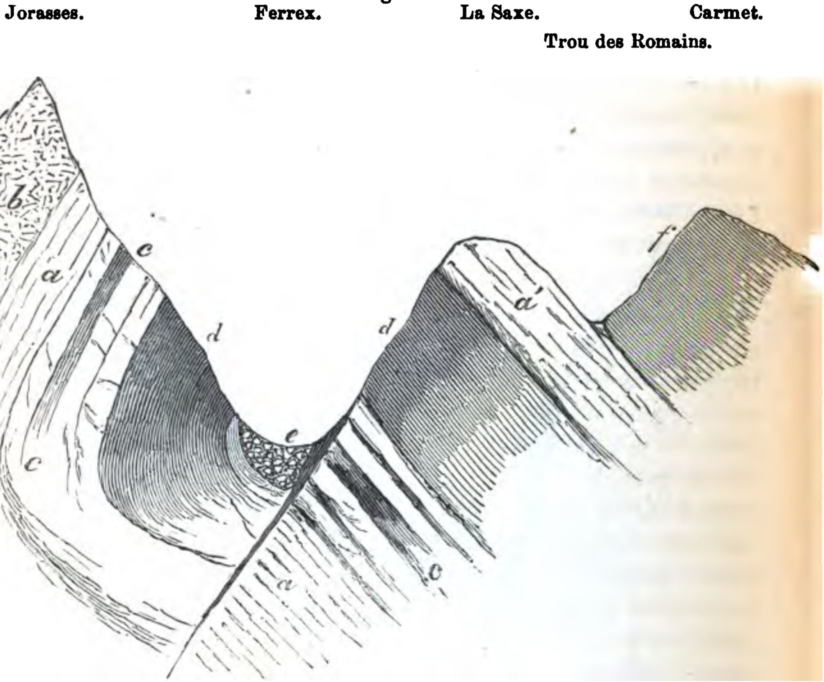
Fig. 7.



a Crystalline schists.—*b* Protogine.—*c* Coal.—*d* Jurassic slates.—*e* Detritus.

On the east side—that is to say, in the Val d'Entrèves—there exists, we shall suppose, a fault. This opinion is supported by the fact, that the dark slates which lie beneath the feldspathic rocks of Mont Chétif and Montagne de la Saxe, are separated from the gneiss of the main chain by a large zone of calcareous and siliceous strata. Also the igneous masses near Cormayeur are by much too insignificant as to have, at the time of their eruption, thrown upside down all the sedimentary formations between Pré Sec and the Col de la Seigne, and those resting upon them conformably from the eastern side. I believe the feldspathic layer of La Saxe, above described, to have been formerly in a horizontal position, and then to have been tilted up by the occurrence of a partial elevation of the surface, similar to the process which Hausmann* supposes to have taken place in the Harz. There is one difficulty, however, in accepting this theory. I refer

Fig. 8.



a Crystalline schists.—*a'* Feldspathic rocks,—*b* Protogine.—*c* Grits and limestones of the coal.—*d* Jurassic slates.—*e* Detritus.—*f* Dark slates.

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* De Mont Hercyn. Form.

to the western dip of the slates in the upper part of Val Ferrex. Either must we detect, or at least suppose, a transversal fault near Pré Sec, or we shall be obliged to admit of some peculiar local disturbance:

The question, at what intervals of time, and in what order, the revolutions which affected the Mont Blanc region might have taken place, need not be at present considered. But I think that the cleavage of the Neptunian slates, and the foliation of the crystalline schists were formed at the time of the eruption of the protogine, and of the heaving of the sedimentary beds. Thus it will be most easily understood that all the main sets of divisional planes which have been treated of, run parallel along the axis of the chain, and that they form a fan in the Mont Blanc, and an anticlinum in the Aiguilles Rouges.

The valleys permeating the Mont Blanc chain, and in the bottom of which the glaciers slowly descend, most likely have been formed by sinkings of ground, at a period corresponding to the time of the general elevation in that quarter. Afterwards the waters, and perhaps the action of *electricity*,* aided by the natural divisional planes, gave birth to the picturesque shapes of these mountains, and occasioned the boldness of their peaks, so much admired.

The few petrifactions hitherto met with in the Neptunian slates in the neighbourhood of Mont Blanc, prove their identity with certain formations of Savoy and of the Tarentaise, which have been minutely examined. They are more recent than the palæozoic, and older than the oolitic, formations. The former point has been asserted and proved by Buckland† and Bakewell,‡ in opposition to Brochant de Villiers;§ the latter has been disputed by Sharpe alone, as follows:—The lias, he states, as well as the older beds of the oolitic series, shows everywhere in the Alps a distinct cleavage. The rocks of the middle oolite do not cleave, except in their harder beds, while all the rocks above are thoroughly divested of any cleavage; therefore the formations of the Bonhomme are the same as those of the Saanetsch; that is to say, they belong to the middle oolitic series. If we do not admit the conclusiveness of this argument, then the formations of the Mont Blanc region are to be ascribed either to the coal measures or to the lias; for the trias, as entering into them, has only been spoken to by Fournet, and even by him with apparent hesitation.

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* Lyell (Princ. of Geol.), informs us of several striking phenomena of that kind having taken place on the Shetland Isles.

† Ann. of Phil., 2d ser., v. 1.

‡ Bakewell, Travels, 1823.

§ Ann. de Min., vol. xxiii.

On various spots, for instance to the west of the Col de Balme, and near Servoz, there have been found impressions of *Stigmaria*, and of other plants belonging, according to Brongniart, undoubtedly to the coal measures. In close proximity to these, there have been discovered Belemnites and Ammonites. Such are also to be met with on the top of the Aiguilles Rouges, above Les Ouches, in the Val Ferrex, and other localities. Deshayes, d'Orbigny, and Von Buch did not hesitate to consider them as proofs of jurassic formations. Both these kinds of petrifactions have not as yet been proved to exist in the same stratum. But sometimes, as at Petit-Cœur, they have been discovered to lie so close to each other, in alternating beds, that they seemed to belong to the same formation; and many have so insisted.

Gras* ascribed the whole series, including partly the gneiss, to the coal; Burat† to the lias, conceiving that a sort of archipelago, possessed of a warm climate, and covered accordingly with the vegetation of the coal measures, rose out of the jurassic ocean. Elie de Beaumont and Sismonda concur in the same opinion, and have tried to illustrate it by the example of plants and their seeds being now transported from the tropics to northern sea-shores. Favre,‡ on the other hand, maintains the improbability of coal-plants having thus floated until the deposition of the jura, or having been more quickly conveyed by oceanic currents. He feels rather inclined to adopt, with Gueymard and Héricart de Thury, the idea of two distinct formations; and he has been confirmed therein by the result of his own inquiries, more especially by those which he made in the Department de l'Isère. He asserts particularly the fact, that, on different spots, the beds containing vegetable remains, and those with imbedded mollusca, dip abruptly against each other, as well as against the crystalline schists. Their being found in other instances alternating with each other, is, according to him, owing to their having been subjected to a process of folding. Ewald, while on the whole coinciding with Favre's opinion, thinks, at the same time, that, should later observations make the above distinction impossible, the formations of the Mont Blanc region would likely be altogether ascribable to the coal formation. This view appears to me to be the soundest one.

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* Ann. des Min., 1839.

† Burat, Les Mines de France.

‡ Mém. de la Soc., de Genève, tom. lii.

Nevertheless, it would be very difficult, with all our present knowledge of the matter, to determine the limit to which the crystalline schists may be regarded as transformed Neptunian sediments, or, like the protogine, as being of igneous origin. However, I would not like, with Murchison, to ascribe the gneiss of the Alps to the transition period; for so admitting, either the elements of this formation would appear rather too widely scattered, or the metamorphism of rocks must have overspread the Alps to a much greater extent than has ever been generally received.

Egypt and Nubia,—their Climate, Character, and Merits, as a Winter's Residence for the Invalid. By Dr DICKINSON, Liverpool.

Compelled by illness to withdraw for a time from the active duties of an arduous profession, I endeavoured to regain health in a climate brighter, dryer, and milder than our own, and visited in its search many of the most frequented and favoured places of resort both in England and on the continent of Europe, but in vain. I was then induced to try what the climate of Egypt and Nubia could accomplish, and here I found that which I had so long sought for. Having paid considerable attention to the character of this climate, and its effects on myself and others, I propose briefly, though I fear very inadequately, to describe them, under the conviction that every trustworthy contribution, however small, will be considered by the scientific inquirer as tending to render more precise and accurate our knowledge of questions of great practical importance, and concerning which many erroneous views and false impressions prevail, even among the members of our own profession.

Alexandria is not a place which an invalid from this country would willingly select for a winter's residence; for though during the summer rain rarely if ever falls, it does so frequently and abundantly in winter, and the temperature then is also low and unequal. Even during the period when the sky is clear and no rain falls, the air is saturated with moisture, and occasions in the invalid a feeling of languor and oppression. Besides, the lake Mareotis, with its mixture of fresh and sea waters, and the numerous ancient underground cisterns sadly tend to render Alexandria the abode of fever, ophthalmia, and dysentery. It is calculated, from the returns of the last twenty years, that one-tenth of the entire population die off annually from fever alone. Dysentery here, as throughout the Delta, is very destructive at certain seasons, and ophthalmia in its mild and severe forms is met with in every direction. Dyspepsia is very prevalent among the European residents, and the sufferers from bronchitis are numerous. The cholera has also had in its visitations a larger share of victims here than in most other towns. The records of the plague show that it makes its appearance in Alexandria many days earlier than in the interior. In March 1835, 4250 persons died of plague, besides many whose deaths were not recorded, out of a population not exceeding 30,000. Two-and-twenty years previous to this,—namely, in 1813,—7000 persons are said to have died of plague out of a population then not more than 12,000." The plague is exceedingly rare in Upper Egypt and Nubia. The writer from whom the above remarks are quoted adds:—"The climate of Alexandria is, on the whole, salubrious, and was considered eminently so by the ancients." And indeed this was the opinion, it would appear, of Diodorus, Celsus, Strabo, Quintus Curtius, and other ancient writers. As a place of vast commercial importance, Alexandria must be ranked very high, but its ancient salubrity as well as its grandeur have disappeared. At the present time, poverty, degradation, filth, and disease, combine to finish the picture which the swarms of mosquitoes, the small but most irritating sand-fly, the midnight Arab funeral wail, the early crowing of innumerable cocks, the incessant braying of donkeys, the howling and growling of miserable starving dogs, might otherwise have left incomplete.

Cairo has of late years been much resorted to by European invalids for a winter's residence, and in many points of view it possesses very decided advantages over most places in Europe. Few places are more amusing and attractive to the European visitor, nor are its attractions soon or easily exhausted. The numerous Saracenic palaces and mosques, with their beautiful minarets, splendid domes, and richly ornamented porches and cornices; the lofty flat-roofed houses, with their curious projecting and iron-barred or quaintly-carved windows; the fountains, with their luxuriant carving and Arabic inscriptions; the bazaars, stored with the various productions of the East; the baths; the lofty citadel, with its extensive and most interesting prospects; the narrow and crooked streets, affording shelter alike from the scorching rays of the summer's sun and the winter's blast, and presenting a wondrous architecture without symmetry, and yet strangely harmonious and pleasing; the strange commingling of costumes and nationalities of the past and present, the Christian and the Moslem; these, and other sources of instructive gratification, are met with without risk and without fatigue. The neighbourhood, too, abounds in objects of interest. The hotels, now, especially those in the Uzbekieh, or Great Square, are good and moderately cheap, from 8s. to 10s. per day.

There are, however, some serious drawbacks, which render it desirable for the invalid not to spend the whole winter in Cairo, but to pass up the river to the drier and more healthy region of Upper Egypt and Nubia. The winds, occasionally very strong, which prevail here from the end of summer until April, are mostly from the north, and bring with them after sunset heavy and cold fogs, which render the nights chilly, and dangerous to those exposed to them without being sufficiently protected by warm woollen clothing. The lowering of the temperature after sunset is often very sudden, and generally great, continuing until sunrise next day. Nearly all who have spent much time in Cairo will agree in the truthfulness of Sir James Clarke's remarks: "The wind is sometimes unpleasantly high, and the mid-day sun oppressively hot; the temperature during the night also falls considerably. This great difference between the temperature of the night and that of the day forms a remarkable feature, and at the same time the greatest defect, in the climate of Egypt." This may be said of the whole of Egypt below Thebes, and with much force as regards Cairo and the region between it and Alexandria; but it will be found that the temperature above Thebes very rarely, and in Nubia still more rarely, sinks below 50° Fahr.

Tables of temperature for Cairo have been given by Dr Abbot, Niebuhr, and others, in Mr Rhind's useful little volume, and by others; but the majority are certainly imperfect as regards the night temperature. This is strikingly the case in Dr Barclay's Tables, published in the "Medical and Surgical Journal," October 1854, and quoted in full, with the highest eulogium, by Dr Copland in his able "Medical Dictionary." Dr Barclay must have omitted to put his thermometer out of the window. He gives the lowest point at night (December and January) at 57° Fahr., and the highest by day (December and January) at 64° Fahr., the greatest diurnal range being only 7° Fahr. Indeed, the greatest diurnal range which he gives between December 25th and March 7th is only 8° Fahr., and the greatest diurnal range during the whole winter and spring is only 14°. If Dr Barclay's tables afforded even an approximation to the truth, the principal objections to the climate of Cairo would fall to the ground; but the whole of his tables for Egypt are so much at variance with the observations of nearly all on whom dependence can be placed, that I cannot but suspect that some grave error has crept into them.

It is well known to residents at Cairo that the thermometer frequently sinks there below the freezing point; for as Mr Traill, many years superintendent of the Garden at Rhodah, informed Dr Bromfield, "hoar frost is no uncommon thing here in the winter months," and he has seen ice, thin, of course, formed on pools in the desert. Others have informed me that they have observed the same thing; and Mr Headland, the superintendent of the sugar factory at Rhodah, nearly two degrees above Cairo, states that the canes are occasionally much injured by frost in this latitude (28°), and that in January sharp hoar frosts are not unfrequent, ice having been formed last winter there one-fourth of an inch in thickness. Even at Esne (latitude 25°) we observed the thermometer to sink to 37° Fahr. on the night of the 20th of February 1857. This, however, was during the prevalence of a strong northerly wind, which continued for three days and nights so forcibly as to render every effort to move down the river by rowing nearly altogether futile. But in Cairo I found, in December 1856, the temperature more than once below the freezing point. On the last day of that month the temperature was in the sun, maximum, 110° Fahr.; in the shade, maximum, 72° Fahr.; and the lowest temperature at night 46° Fahr., there being a slight southerly wind.

During the winter, for the most part, the sky at Cairo is clear, the air in the day dry, and the mid-day heat pleasantly tempered by the north winds, whilst the night fogs nearly always disappear soon after sunrise. It has been calculated by Mr Rhind that, "taking an average of six years, at various intervals between 1762 and 1856, from the middle of November till the middle of April, rain appears on about fifteen days and nights, chiefly in January and February; but on the majority of these the fall is confined to a few drops, or some slight showers." On the whole, the climate of Cairo may be safely recommended as salubrious and well adapted for a winter's residence for a large class of invalids who are unable or unwilling to avail themselves of the superior climate of the Thebaid and Nubia. Towards the end of April, sometimes sooner, and during May and early June, the Khamseen (or fifty days' wind), a south or south-east wind, with its parching breath and clouds of impalpable dust, prevails, and all dews cease. Before this wind, so prejudicial to all animated nature, sets in, invalids, Europeans especially, should leave the country, either for Syria, by the desert, or for the warmer parts of Europe, such as Malaga or Southern Italy.

Probably no known climate can boast to the same extent as that of the Thebaid and Nubia of the union of a cloudless bright sky, a pure warm atmosphere, combined with unequalled freedom from moisture and great steadiness of temperature as from day to day. Sir James Clarke writes thus:—"I believe there is to be found in no part of Europe a climate possessing these qualities (warmth and dryness) in so eminent a degree during the winter as that of Upper Egypt. At this season, indeed, the Egyptian climate, in point of warmth, dryness, and steadiness of temperature, is superior to any noticed in the preceding pages (viz., those relating to Europe); and in regard to the two first-named qualities it surpasses every other climate not within the tropics," mentioned in his work. The great defect of the climate here, as lower down the Nile Valley, is the great difference of temperature between day and night. Happily, however, this is a defect which can be guarded against by very simple precautions. In this respect it contrasts unfavourably with Madeira, as it also does in regard to the difference of temperature between one season and another, and the daily successive range. This remark will apply in a minor degree to some other places. The climate of Egypt, however, has, in its union of good qualities, independent of its dryness, more than counterbalancing recommendations.

Lepsius thus writes from Thebes on the 13th of October 1843, and his remarks will be just for the greatest part of the winter in the Thebaid and Nubia:—

"No one ever inquires here about the weather, for one day is exactly like the other—serene, clear, and hitherto not too hot. We have no morning or evening red, as there are neither clouds nor vapours; but the first ray of the morning calls forth a cloud of colours in the bare and rugged limestone mountains closing in around us, and in the brownish, glittering desert, contrasted with the black or green-clothed lower plain, such as is never seen in northern countries. There is scarcely any twilight, as the sun sinks down at once. The separation of night and day is just as sudden as that between meadow and desert—one step, one moment, divides the one from the other. The sombre brilliancy of the moon and starlight nights is so much the more refreshing to the eye which has been dazzled by the ocean light of day. The air is so pure and dry, that except in the immediate vicinity of the river, in spite of the sudden change at sunset, there is no fall of dew. We have almost forgotten what rain is, for it is above six months since it last rained with us in Sakara. A few days ago we rejoiced when, towards evening, we discovered some light clouds in the sky in the south-west, which reminded us of Europe. Nevertheless we do not want coolness, even in the day-time, for a light wind is almost always blowing, which does not allow the heat to become too oppressive. Added to this, the Nile water is pleasant to the taste, and may be enjoyed in great abundance without any detriment."

The grand peculiarity and excellence of the climate of the Thebaid and Nubia is its dryness, which is evidenced by many remarkable facts. The rock temples and tombs exhibit, in their primeval freshness, paintings above three thousand years old: and linen, fruits, meats, bread, and other materials quickly perishable in moist climates, are here preserved as if unaffected by decay, and affording convincing evidence that year after year the climate retains this characteristic feature. I never met with a single conferva, lichen, or moss throughout the whole Thebaid or Nubia, though most diligently sought for; and the difficulty of bringing fresh specimens of plants uninjured to the boat for preservation in the herbarium was exceedingly great, as they became so soon dessicated and shrivelled up.

The air of the desert is even drier than that of the Valley of the Upper Nile, and is remarkably buoyant, refreshing, and invigorating; though here also there is a very marked difference between the temperature of day and night, as we found by experience. In some parts of the desert the temperature from day to day is very equable, and the diurnal range not very great; but in this respect the desert localities greatly differ. Rhind states that his observations corroborate, with regard to dryness, those of Dr Barclay, who found, "taking zero to represent drought in England, that his hygrometer showed a mean of 7·5° of dryness, when sailing between Thebes and Assouan, from the 17th to the 23d of January, while the mean was 12·2° in a tomb at Geezeh for a corresponding number of days from the 13th to the 19th of March, the temperature at both periods being very nearly identical, and the same bright, cloudless weather prevailing."

Rain is nearly unknown in Nubia, and is also very rare in Upper Egypt. During nearly three months spent on the Nile in 1857 we had only three showery days, and on two of these the showers were only very slight and short. A friend just returned from Egypt, and who has furnished me with some very valuable information regarding the weather on the Nile during the last winter (1857–58), informs me that during more than three months they had only one shower (at Edfoo, on the 5th of February). Even the above appears to be beyond the average number of wet days, if we are to credit the statements of travellers. Pococke "had been told that there, in eight years, it had been known to rain but twice very hard for half-an-hour." Satisfactory evidence, however, exists, both on the Mokattam and Libyan hills, that very heavy rains do occasionally fall throughout Upper Egypt, for they exhibit numerous deep water-courses with well-marked traces of the force and rapidity of the torrents. On the 17th of January, near Girgeh, latitute 26½°, there was in the evening much lightning and some thunder, with occasionally a squally wind, occasioning some danger to our boats. During the night there was a very heavy shower, and on the following day two more such. Lepsius writes:—"At Assouan we were obliged to change our boat on account of the cataracts, and for the first time for six months past, or longer, we had the home enjoyment of heavy rain and a violent thunderstorm, which gathered on the farther side of the cataracts, crossed with a mighty force the granite girdle, and then, amidst the most violent explosions, rolled down the valley as far as Cairo, and (as we have since heard) covered it with floods of water, such as had been scarcely remembered before. So we may say with Strabo and Champollion, 'In our time it rained in Upper Egypt!' Rain is, indeed, so rare here, that our guards never remembered to have beheld such a spectacle."

Lightning and thunder, especially the latter, are, however, extremely rare in Upper Egypt, and it is mentioned by Aymé (Description d'Egypte, I., 135), that during two years he heard only a single clap of thunder, and that so faint as to escape the notice of several persons around him.

A clear sky and high daily temperature of the air are favourable to the development of heavy dews, and these are consequently much seen in Middle and Lower Egypt, especially when the north or west winds blow, as they come from the Mediterranean surcharged with moisture. On the contrary, dew is nearly altogether absent when the winds blow from the south or the east, as the hot arid sands of the desert completely desiccate them before they reach the Nile valley. There is also little or no dew in Nubia, except on the river, and that is so slight as scarcely ever to leave any perceptible moisture on the boat. Volney has stated that dews are most frequent in Egypt during the summer, but this is altogether incorrect, for very numerous carefully-made observations have demonstrated the contrary.

It is an interesting fact that the temperature of the Nile water was never found to be lower than 56° Fahr., generally about 60° Fahr., the difference being due to the sand-banks and depth of current, whilst the surrounding atmosphere was often from ten to fifteen degrees lower; the mean of the minima being 52½°, and if we deduct the bright night temperatures of Nubia, which on the 8th February 1857, at Derr, reached 70°, the mean of the minima would be below 50°. Mr Spencer Wells found the mean minima in a voyage up the Nile in 1849–50 to be only 45° Fahr.; and I am informed that the mean of the minima of the last winter (1857–58) was still lower.

Herodotus thus writes:—"The Egyptians, next to the Libyans, are the most healthy people in the world, as I think, on account of the seasons, because they are not liable to change;" and it would appear from the inscriptions on the tombs, and similar sources of information, that the inhabitants of the Nile Valley really did enjoy a very remarkable longevity. Prosper Alpinus has devoted a whole chapter of his celebrated book to this subject. Morton, in his "Crania Ægyptiaca," remarks, that amongst 100 skulls taken at random, he calculated that there were two of from 60 to 70 years, three of from 70 to 80 years, and two of from 80 to 90 years old—a proportion far greater than is to be met with amongst European nations, where scarcely two persons aged 90 years are found amongst one thousand. It has also been inferred, from observations made in the tombs, and from the comparative scarcity of mummies of children, that owing to the care bestowed on infants, and the genial influence of the climate, the mortality amongst them was very slight. The mortality amongst children in Egypt is now, however, exceedingly great, nor does it remarkably diminish until after puberty. This does not arise principally from epidemics, such as small pox (which do, however, sweep off vast numbers), but mainly from filth, neglect, and mismanagement. Early marriages also doubtless somewhat contribute to it, as also do the numerous intermarriages between near relatives. It is no unusual thing for a girl of twelve years of age to be married and a mother, and become a wrinkled hag at forty or forty-five years of age.

The males, however, having arrived at maturity, seem remarkably free from disease, and are often muscular and well formed, though not in general long lived, as might be expected from their habits, &c. It is therefore "rather staggering," says Rhind, and few will here dissent from him, "to find Father Alvarez declaring, in the early part of the seventeenth century, that he had seen in Ethiopia powerful men at 150 years of age, and that in Egypt there were more old men than in any other country on the face of the earth."

Neither time nor space will allow of our entering into a detailed account of the diseases prevalent in Egypt. This has been done already by Clot Bey, in his "Aperçu General sur l'Egypte," and M. Pruner, in his "Topographie Medicale de Caire." It may be sufficient to refer the majority of these diseases either to miasmata, occasioned by the stagnant pools of Lower Egypt, or left by the inundations of the Nile; to the great heat (at certain seasons) by day and comparative cold by night; to the bright sun and fine sand dust diffused through the air, and to the filthiness and misery of the people,—or to the combination of these agents.

Dysentery and ophthalmia are the diseases most prevalent throughout Egypt, and are probably mainly due to exposure to draughts of cold air when the body is heated. They are in general much more easily cured now than formerly, probably because the diseases are of a milder type, and the treatment is better understood. The formidable ophthalmia, which committed such fearful havoc in the French and British armies at the commencement of this century, is now nearly altogether unknown; and although the proportion of natives (Fellaheen) labouring under the loss of one or both eyes, or of the disease in some of its forms, is still fearfully great, yet doubtless this is owing to the neglect of proper treatment, which is, when judiciously used, attended with almost unfailing success, and the restoration to health of the diseased organ.

Phthisis is much more rare in Egypt amongst the natives than with the residents of any region in Europe. To a certain extent the same may be said of the Europeans who have fixed their permanent abode here. Not so, however, with the Abyssinians and Nubians, who enjoy in their native land an almost perfect immunity from consumption, but who perish from it in vast numbers when they are brought down to Middle and Lower Egypt.

As the northerly winds set in about November, and the climate of Cairo is then not too hot for the European invalid, he may safely arrange to arrive there at the beginning or middle of this month. The ascent of the river should be commenced before its expiration, so that Thebes may be reached in December. Here he may remain some little time, arriving in Nubia in the beginning of January, before which time the climate is too hot; and leaving it again about the middle of February, for the same reason. Resting again for a short time at Thebes, the invalid should arrange to reach Cairo before the middle of March, at which time the heat on the Nile is too great to render a boat residence at all agreeable. Here he may remain until the end of the month, when the climate of Cairo itself begins to be too hot for an European invalid.

By a well arranged journey of this kind, extending over a range of from Cairo, latitude 30° N., to the second cataract in Nubia, latitude 22° N., and back, the invalid may enjoy one continued series of bright, warm days, with cloudless skies, and a dry, balmy, exhilarating atmosphere, the mere inhalation of which to a debilitated or bronchitic patient is an indescribable luxury. He feels, too, that this state of things is not merely an accidental occurrence, but one on which he can safely rely from day to day, with but very few exceptions, and he makes his arrangements accordingly, so far as the weather is concerned, with almost mathematical accuracy.

No reasonable person can now complain of the dietary on the Nile, which, though not very varied, may be made sufficiently so, and practically generally is so, and almost always well adapted to the climate. The number, variety, and excellence of the dishes supplied to our table were often a subject of very agreeable surprise.

The annoyance from vermin on the Nile has been very much exaggerated, and the boats are now fitted up with scrupulous cleanliness and regard to the comfort and tastes of European invalids. Nor is there now anything which need deter a delicate-minded lady undertaking the voyage.

There are some, however, and we have met with such, who not only derive no advantage by leaving the comforts of their English home and wintering in Egypt, but, on the contrary, essentially suffer from it. These are either they who labour under some sub-acute disease, or whose symptoms are too far advanced to enable them to bear with impunity the little inconveniences and occasional annoyances inseparable from a boat life with Arab sailors; or they are those who neglect the precautions which are essentially necessary for the full development of the advantages of a Nile voyage. The great difference of temperature between night and day, even in the shade, independent of the bright mid-day sun and the night fogs, render it desirable that invalids labouring under chest disease should not expose themselves outside the boat much after sunset nor before sunrise, and certainly never without being protected by sufficient woollen clothing. These latter precautions are not so much needed between Thebes and Wady Halfa (second cataract), as the nights there are warm and free from dew. Nor should the weak and enervated needlessly expose themselves, as some do, for many successive hours, to the direct rays of a scorching sun, or imbibe for nearly an equal period the mephitic air of the interior recesses of the tombs or of the great pyramid.

It has been remarked by a recent writer on the climate of Algiers, " It is not of small moment to the invalid that pleasure and amusement meet him at every step, that he has neither fatigue nor risk in seeking them; that they are all of a nature to amuse without exciting him, adapted to all tastes and to all capabilities.

"In this point of view Algiers contrasts most favourably with other places of resort, where the objects of interest are chilly cathedrals, cold picture-galleries, and such like, which fashion demands the stranger shall visit, be he an invalid or in health, and for which he must assume a spurious enthusiasm if from defect of nature or education he lacks the taste. It is of real importance that the invalid shall leave his room, not full of some excursion to a cathedral or ruin, but simply to be in the open air, to wander about where his fancy may lead him, sure of finding himself gratified and amused. He returns ere he feels fatigue, for he has no prescribed mission or task which he must accomplish, in good spirits and refreshed, with as much to talk of and think of as he can desire."

Admitting the force of the above truths, it may safely be asserted that in all these particulars, as in most, though not all others, Egypt ranks much higher than either Algiers or Madeira as a winter resort for the European invalid. The respective peculiarities and merits of each of these, as well as those of Southern Italy, &c., need not now be pointed out.

In addition to the numerous and undoubted advantages enumerated above, and which, in combination and perfection, I believe, the climate of Upper Egypt and Nubia possesses over every other yet known to us, it has many others which should not be lightly passed over. The dyspeptic, and the sufferer from chest complaints, the rheumatic, and the man whose constitution has been impaired by sedentary habits, anxious or harassing pursuits, or irregular living, may here, if anywhere, find the necessary means for recovering his lost vigour of mind and body.

In a brilliant and balmy climate, where mere existence is felt to be a positive luxury, and where the mind enjoys a serenity almost unknown in our foggy land, there is scarcely ever experienced any feeling of *ennui*, even when the traveller is confined to his boat, and that passing but slowly up the river by tracking. The naturalist, and especially the entomologist—the botanist in a minor degree—may ever find material for examining and collecting. The sportsman may with his line or gun always meet with abundant occupation. The archæologist and antiquarian reap a rich harvest in the examination and contemplation of the wondrous remains of ancient art and science, as seen in the temples and tombs. The visits to adjoining hamlets—marking the habits and customs of the people, which illustrate so powerfully Sacred Writ and classical authors—the pleasing intercourse between fellow-travellers going up or returning down the Nile, and the interchange of books and newspapers—making meteorological observations and entries in the diary, with a moderate proportion of pleasing and instructive reading—noticing the distinctness of the geological features, or the peculiar appearance of the moon, as white when on the horizon as in mid sky, or the sun setting in a glory indescribable, to be succeeded by constellations brilliant and beautiful—admiring the deceitful mirage, or tracing the course and direction of the lofty sand-pillar—sketching the various objects as the panorama glides slowly and pleasantly by—these, and similar pursuits, cause the day to pass away so quietly and agreeably, that at the end of the voyage one is surprised to find that so much time has for ever fled.

Notes on the Habits, &c., of a few of the Animals of various parts of Hindustan and the Western Himalayan Mountains. By A. LEITH ADAMS, M.B., *Surgeon 22d Regiment. In a Letter to* Sir W. JARDINE, Bart.

Felis tigris (Linn.).—Plentiful on the western frontier of the Punjab, on the banks of the Indus. A few occasionally stray along the N.W. frontier as far as Attock, and in the jungles of the Salt Mountains; but it is seldom seen in the Himalayan valleys, although individuals wander sometimes a considerable distance inwards. One was killed at Poonch, among the southern Cashmere ranges.

Felis pardus (Linn.); called *Cheetah*, *Sher* (a name applied likewise to the tiger), *Bagh*, &c., by the natives of the lower Himalayan Mountains, where it is pretty common, frequenting dense jungles or forest; preys chiefly on musk-deer, or domestic sheep, goats, &c.

The presence of this cheetah is often discovered by the barking of foxes, the loud bellowings of the Sambur and Cashmere stag, or the harsh notes of the bulbul or beautiful long-tailed pie (*Pica erythrorhyncha*, Vig.) It is the most common species found on the western Himalayas; but from native reports it would seem there are either many varieties, or more species, mostly confined to localities where their particular description of prey abounds. Thus, I have heard of the *Burrel hay*, found at high elevations in Great Tibet. It preys on burrel and musk-deer. It is of a dirty-white colour, with black spots. This, in all probability, is the *Felis uncia*, and is found in the northern Cashmere ranges, and Ladakh. I have frequently seen the skins of this species in the possession of fakîrs in the western range; and they are brought likewise from Affghanistan, and sold in the bazaars at Peshawur*. The *Adder hay* is said to be closely allied to the *Pardus*, but is of smaller size. Frequents the same localities. Whether a variety or not, I am unable to determine. There is one which lives mostly on gooral, called *Gooral hay*. The colour of the skin is said to be lighter than the last; and it is very much smaller in size. I have not seen either of the last-mentioned. Altogether five different species or varieties have been described to me by natives or European sportsmen.

1. *Bayherra*, or *Felis pardus*.
2. *Burrel hay*, probably *Felis uncia*.
3. A cheetah without spots, found at high elevations in Tibet and Chinese Tartary.

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* All the skins I have examined were dirty white, with *black spots*, the fur was long, thick, and soft; tail long and *very* thick.

4. *Adder hay*, smaller, but very like the *Pardus;* head more rounded and bull-dog like.

5. *Gooral hay*, a small species, and may be one of the tiger-cats, but not the *Felis* (Leopardus) *pardochrous* (Hodgson), nor *horsfieldii*.

Felis (Leopardus) *pardochrous* (Hodgson).—Seen occasionally on the ranges around Simla.

Felis (Lynx) *chaus* (Güldenst).—Punjab. Common. Preys chiefly on rats and mice; frequents ravines and broken up-country.

Cuon primævus (Hodgson); *Ram hun* of the Cashmerees.—Although generally distributed over the western Himalayas, and extending northward even beyond the limits of forest, the Ram hun is seldom seen; so cunning and stealthy are its habits, that I have frequently been informed by native sportsmen, that, although daily familiar with its depredations, they have failed to discover the animal. A friend informed me that he saw a herd of deer (*Cervus cashmeriensis*, Falc.) pursued by a pack of wild dogs in full cry. Like the jackal, it prowls at night, and secretes itself in burrows or caves during the day. It is not plentiful to the westward of the Sutleje, but is now and then found on the Cashmere ranges. One was killed by Lieutenant Abbot, 75th regiment, near Allahabad Serai, in the southern Cashmere mountains, and afterwards indentified with specimens in the East India Company's Museum in London. Native reports relative to the wild dogs of the western ranges of the Himalayas are so varied, that it may be questionable, if not many varieties, there may be more species. These remarks do not refer to the pariah dog, which, although often forced to depend on its own exertions, and to wander over large tracts of country in the plains of India, I have never seen do so on the western Himalayas, or anywhere assume a really wild state, or hunt in packs, in these countries. The Ram hun is bold and ferocious. Natives say there are few of the larger quadrupeds it will not attack, and that ibex, deer, burrel, &c., are frequently killed by it.

In a collection of skins from the Kara Korum Mountains, north of Ladakh, made by Lieutenant Peyton, 87th regiment, I saw the skin of a wild-dog or wolf, probably a new species. It was imperfect, yet the animal appeared to be about the size of the shepherd's dog; nose pointed; hair long and thick, and containing much under-wool, called *Peshmena;* prevailing colour white, with black patches on the back and hips; tail short, somewhat bushy, with the tips of the hairs black. I was told that they are frequently seen near the dwellings of the natives, and that they hunt *Ovis ammon*, Nahoor, and Tibet antelope (*Kemas hodgsonii*).

Vulpes montanus (Gray); Loh of the Cashmerees.—Generally distributed over the lower and middle regions of the western Himalayas, and is never seen in the plains of India. Prefers cultivated districts, and preys on poultry, young hares, partridges, pheasants, &c.

A fox is common among the ravines and broken up-country in the Valley of Cashmere, and burrows on the sides of the *Kirruas* (small steeps). It is larger than the *V. montanus*, and of a lighter brown colour. The natives call it "Shawl," to distinguish it from the last, which is found in the mountains around the valley. I saw many, but never procured a specimen. If not the *V. flavescens*, I think this is probably a new species.

Martes flavigula (Bodd.)—Lower and middle regions of the western Himalayas. Pretty common. Is easily domesticated when caught young. One followed me about like a dog. They are very active, climb trees with ease, and commit great havoc in poultry-yards, where they destroy eggs and young fowls. Small reptiles, such as lizards and snakes, constitute their favourite food. The colours of the summer and winter dress differ considerably, that of the latter season being much lighter, while the dark robe of mid-summer so much resembles the *M. Gwatkinsii* that I have been frequently disposed to think there is no difference.

Mustela Putorius; Subhema chalana (Hodgson).—I killed a specimen of this weasel in the Valley of Cashmere, where I was informed by the natives that it is pretty common, and destroys young poultry and eggs. It is generally distributed over the middle regions of the western ranges.

Ursus isabellinus (Horsf.); Brown and white bear of Europeans; *Reech Balu* of the natives of the western Himalayas; *Harput* of the Cashmerees.—The distribution of this species on the western Himalayas is not so general as in the case of the black bear (*U. tibetanus*). A few are found at the sources of the Ganges and Jumna, but none in Little Tibet. Their headquarters seem to be among the mountains forming the northern boundary of the Valley of Cashmere, where they were extremely plentiful until within the last few years. In the Valley of Wurdwun, situated north of Islamabad, not more than six miles long, and in many places not a mile in breadth, brown bears were so abundant that as many as thirty were killed during the spring of 1851 by one individual, but they are now almost extinct in these regions, owing to the numbers of European sportsmen who visit Cashmere. This species is larger than the next; the largest male I have seen measured 7 feet 6 inches in length, height 41 inches, round the body behind the shoulder 58½ inches, round the arm 24 inches, round the thigh 37 inches.

The brown bear prefers high and rugged mountains near the confines of perpetual snow, with fertile valleys at their bases,—hence the Cashmere ranges are well adapted to the habits and taste of this species.

During winter they repair to caves in rocks, and form their beds of decayed leaves, usually ferns, in which they lie until spring, when, as soon as the snows melt and vegetation appears, they issue from their retreats. They are at this season lean and very voracious, and will attack sheep or goats, and even ponies are said to have been killed by them. The fur during winter is long and shaggy, but becomes thinner and darker as the season advances, so that towards autumn the under fur has disappeared, and the white colour on the chest, indistinct in the winter garb, is now very visible; this latter may have given rise to the many mistakes regarding two or more species. The shades of colour vary much; it was observed that the bears seen in spring were always lighter in colour than those seen in autumn, and occasionally an almost white variety was to be met with, and various shades, from a dirty-white to a dark-brown. Many of the old males were of a very dark-brown; it was evident, however, age or sex had nothing to do with the shades of colour.

The female appears in spring with one or two cubs, and rarely three. When caught young they are easily domesticated, and become harmless and playful; indeed, the old ones, even when wounded, seldom attempt to charge.

The *Ursus labiatus* is not found in the Punjab or on the Himalayas.

Helarctos tibetanus (Cuv.); Black bear of Europeans — called *Reech Balu* by the natives of the Lower Himalayas.— This species is generally distributed over the lower and middle regions of the western Himalayas, but not to my knowledge in Great Tibet, and certainly not in Little Tibet. Unlike the *U. isabellinus*, it does not hybernate, and prefers the forests and cultivated districts of the lower ranges to the high and bare slopes of the interior. Its favourite resort in summer is among thick jungle, near fields or vineyards, and during the grain and fruit seasons it commits great depredations. Its principal food consists of tender shoots of plants, wild rhubarb; in winter, bark of trees, apples, grapes, walnuts, and Indian corn. The natives allege they sometimes eat flesh and kill sheep, but this must only be when hard pressed for food, for this species is eminently a vegetable feeder. They are expert climbers, and during the fruit season in Cashmere mount during night to the very topmost branches of walnut and mulberry trees, of the fruit of which they are very fond.

On the ranges bordering the plains of the Punjab a bear is found rather smaller than the above; its fur is longer, and there is a rust-coloured tinge on the legs and snout. It may only be a variety of the *H. tibetanus;* however this distinction is worthy of further attention (see "Calcutta Sporting Review" for September 1848); a similar remark is made by "Mountaineer," who likewise states that a species with a white mark on the forehead is spoken of by the natives on the ranges north and eastward of Mussouree. However, from my own personal experience, and the information of European and native sportsmen, I have hitherto been able only to discover the two species here mentioned.

Arctomys bobae (P. A. S., 1843, p. 409); *Drun* of the Cashmerees; *Red Marnot* of Europeans.—Is confined to localities at high elevations, and prefers fertile and secluded situations where vegetation returns rapidly and is luxuriant; there this active little creature spends the summer months, surrounded by a plentiful supply of food, until forced to its burrow by the snows of winter. In habits they are social, forming their burrows on gentle slopes or under stones, where they delight to sit, and on the approach of danger emit a loud wailing cry, which is repeated in succession by individuals: in this way a continuous chorus is heard for miles along a hill-side, each marmot darting into its burrow immediately after the alarm is given. The food of this species consists of roots and plants, which, it appears, they store up for winter, as they remain in a semi-torpid state for four or five months, and in many localities for a longer period. It is seldom they roam any distance from their burrows, and more usually remain for hours seated at the entrances. During progression they leap, and sometimes run on the hind legs, using the tail to assist them.

The Lammergyer (*Vultur barbatus*) is a formidable enemy to this species.

In the valley of the Dras River, near Ladakh, Wurdwun Pass, Cashmere, and at elevations on the neighbouring ranges from 8 to 10,000 feet, are their favourite haunts.

Kemas Hodgsoni (Abel. Sp.); Tibet Antelope of Europeans; *Sous* of the Ladakhees. — Found on the borders of Chinese Tartary, north-east of Almorah, and on the northern parts of Nobra Ladakh. Natives report it abundant on the mountains beyond Yarkund. The longest horn out of twenty male specimens measured 27 inches. It is worthy of remark, in many specimens killed in Nobra, there were found under the skin, in the hind quarters, clusters of the *larvæ* of an insect, enveloped in *cocoons* of the size and form of a sparrow's egg; yet this did not seem to interfere with the health of the animals, as they were all plump and in good condition.

Capricornis bub-alina (Hodgson); *Ramu* of Cashmere; *Surou* of the natives eastward of Cashmere.—The Ramu is perhaps the least numerous of all the hill ruminants. Solitary in its habits, it frequents dense jungles and secluded patches of forest among rocks, where it moves about stealthily, and may remain for months in one locality. When wounded, and brought to bay, they fight desperately, and use their short and pointed horns with effect. Natives often say, that when attacked by wild dogs they gore several before they are pulled down.

The young are born in May or June; there is seldom more than one at a litter.

Capra jemlaica (Ham. Smith); *Tare* of the natives generally; *Jujula* of the Cashmerees; *Kras* of the natives on the banks of the Chenaub.—Common on the Peer Panjal ranges, Cashmere, but more so on the banks of the Chenaub, near Kishtewar. Frequently gregarious, and seen feeding with the Markore (*C. magaceros*). Young, a light yellowish-brown, with a black line down the back. Frequents steep rocky mountains, passing the day in forests and shady places.

Capra (Ibex) *himalayana* (Blyth); *Skeen* and *Kial* of the natives. —Is found on many of the lofty ranges of the western Himalayas; the principal localities may be enumerated as follows:—Arserung, Spiti Kenowour, Chinese Tartary, Cashmere, and Ladakh. With reference to the latter country, it was observed, that the species seen there have shorter horns than those found on the ranges immediately north of Cashmere Valley; however, it may be doubtful if they differ in any other particular. A specimen named *C. siberica* from the Altai mountains, in the Derby Museum, Liverpool, appears identical with the Ladakh variety.

During winter the ibex repairs to sheltered and rocky situations; feeds on moss, lichens, bark of trees, and, I have been creditably informed, eats earth at this season. When the snow melts in spring, they move downwards, and feed on the scanty herbage around its margin. A Nardus seems to be their favourite food in summer. During winter they are thickly clad with peshmena or under-wool, of a white colour, which gives the animal a piebald appearance at a distance. The peshmena of the ibex is softer and more valuable than that of the Cashmere goat. During summer the under-wool disappears, and the colour changes to a light brown, with a dark line down the back. The horns of the male have been observed to grow to a very large size. One is recorded which measured 48½ inches round the curve, the length, together with the direction and size, vary much in individuals; commonly it tapers to a point, and proceeds upwards and backwards, with the tips inclining directly downwards; others diverge a good deal, and terminate abruptly, like many of the European species. The average length of a full-grown ibex horn varies from 27 to 38 inches round the curve. One kid is the usual number, although sometimes two, or even three, are born at one birth.

Capra magaceros (Hutton); *Markore* of the natives of the western Himalayas, and mountains around the Khyber Pass, Hindoo Coosh, &c.—The distribution of this species is somewhat remarkable. It is not found on the ranges eastward of Cashmere, and only met with occasionally on the mountains forming its southern boundary. Again, towards the north, it is common in Little Tibet, around Tskardoh, Gilget, &c., and all down the banks of the Indus as far as Torbela; common on the mountains around Peshawur, it wanders down the Suliman range, and has been killed near Mitinkote, at the junction of the Indus and Sutlege, Hindoo Coosh, Afghanistan, Persia, and sources of the Oxus, where it is known as the *Rass.* No less interesting is it to observe the differences in regard to the curvature, form, and direction of the horns in specimens from several of these districts. All seen by me on the Southern Panjal had the horns flattened, with few twists. I killed probably one of the largest males on record; each of its horns measured 52 inches round the curves, had only two perfect and one imperfect turn; while the horns of old males from the Peshawur and Suliman ranges were rounded, straight, and twisted like a cork-screw. One from Herat had the horns like the Cashmere specimens. The Peshawur and Suliman specimens were perfectly straight, and rose perpendicularly from the skull; while the Cashmere ones diverged, and proceeded backward at an acute angle. I have not been able to compare skins sufficiently to say whether there is any difference in them; but from a somewhat extensive knowledge of the habits and haunts of this animal, I am decidedly of opinion that it is a distinct species, and has no more traceable affinity to the *C. hircus* than the ibex or any other allied species.*

They are usually found in small herds; and in habits closely resemble the ibex, preferring steep and rocky mountains, and feed on the scanty herbage near the summits.

The summer and winter dress varies a good deal, the peshmena, as in the ibex, causing the hair to look lighter in winter. The hair is short and grayish-brown, with white marks on the hinder quarters. The adult male has all the under surface of the jaw, neck, and chest covered with long black hair, which hangs downwards to the knees in old males. The females and young have a short black beard only; and the horns of the former are flat, with generally one curve, and seldom more than 10 inches in length. The largest male I have seen stood 11½ hands at the shoulder. In regard to their eating serpents, although the natives assert such to be the case, I have failed to substantiate this statement from my own experience.

Ovis Vignei (Blyth); *Hauriar*, Punjab; *Shapoo*, Ladakh (not Shapoo of Hodgson, J. A. S., Bx. 913); *Kiuch* of the Suliman ranges.—Like the Markore, this species inhabits districts differing much in climate and appearance. It is plentiful in Ladakh and on the ranges westward of the Indus, Kyber Pass, Hindoo Coosh, Suliman, and Salt ranges of the Punjab; is said to abound on the mountains of Persia and Affghanistan. The specimens from Ladakh and Salt mountains differ in some important points. It was observed in every instance, that the horns of the Ladakh animal had the upper surface rounded, and that they invariably proceeded upwards and backwards, with the tips declining downwards and inwards; while the Hauriar horns changed and curved inwards, describing a circle, the tips directed towards the ears. The Shapoo is larger than the Hauriar; and in several specimens shot in summer the long black hair on the under surface of the neck was awanting, but whether this was dependent on season or other causes, I am not prepared to say; countries differing so much in climate and appearance must change in some degree the habits, &c., of the species; yet I think they still require accurate comparison. The *Hauriar* of the Punjab frequents bleak, barren mountains, composed of broken ranges intersected with ravines and dry beds of rivers, where vegetation is scanty at all times, and goats or sheep are seldom driven to pasture. They are fond of salt, and are most abundant in the neighbourhood of the salt rivers; shy and watchful, difficult of approach, they possess in an eminent degree the senses of sight and smell; unless disturbed, they are seldom seen during the day, secreting themselves under rocks until dark, when they make for the valleys to feed all night, and return to their retreats at early morn. The cry of alarm is a loud whistle, like that of the ibex, which is always a signal of departure, and is generally given by the oldest male; the herd, thus disturbed, will keep moving all day, and seldom settle down until dark. The bleat is like that of the sheep, and the males fight in the same way; but its deer-like proportions, together with the infra-orbital sinuses, show a connection with that tribe which has obtained for it the name of "deer-sheep" by Europeans. In speed and activity it is equal to almost any of the Cervidæ, or even the swift-footed black buck (*Cervus benzoartica*). The female gestates seven months; the rutting season is in September.

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* Mr J. E. Gray (Knowsley Menagerie, p. 34) enumerates it as a variety of *Capra hircus* of authors.

Ovis ammon (Linn.); *Nyan* of the Tibetians.—It may be said that little more than the southern limits of this species is yet known. On the borders of Ladakh and its lakes they are found in small numbers; a few are found at the sources of the Ganges; it is said to abound on the Altai ranges, and country around Yarkund. The largest male horn I have measured was 3 feet 2 inches round the curve, and 1 foot 6 inches at its greatest circumference. The horns of the female are about 1 foot 6 inches in length, flat, narrow, and curving backward.

Ovis nahoor (Hodg.); *Sna*, Tibet; *Naboo*, Ladakh; *Burrel* of Europeans.—Is found in Ladakh, Nobra, and Great Tibet. Judging from the numbers of horns I found on cairns in Rupshoo Ladakh, it appeared they were plentiful in that country. I found great dissimilarity in regard to the size and curvature of the horns of the Ladakh specimens. I mention this, as Mr Blyth seems to think that the burrel frequenting the eastern ranges is a different species. I am induced to think this is not the case; the fact of finding horns in the same locality similar to those described as specific differences in the "An. Nat. Hist." 1841, p. 302, goes far to prove they are only casual differences

Moschus moschiferus (Linn.); *Custuree*, Cashmere and west Himalayas; *Russ*, Cashmere.—Generally distributed over the middle and lower regions of the west Himalayas, but not found on the plains of India. The musk deer frequents mountain-sides, where grassy ridges alternate with little belts of forest or dense jungle; there it secretes itself all day, and at dusk, or during early morn, moves silently across the bare ridges to feed. Its mode of progression is performed by a series of jerking leaps, stopping now and then to reconnoitre, then walking a few steps, and so continuing these fantastic-looking movements.

The Custuree has no cry beyond a loud and harsh scream, which is only uttered when caught or severely wounded.

There is much diversity in regard to the external appearances of the skin,—so much so, that a casual observer might be disposed to conclude that there are more than one species; but having observed closely these differences, it is evident to me they are owing chiefly to age and situation: in fact, it is seldom I met with two skins entirely alike. Some had the hair very dark on the upper parts, with black patches on the hinder quarters, and the under parts dirty white; others, yellowish-white on the upper parts with the lower parts white. (Query, "Is the *M. leucogaster*, Hodg. only this variety?") Some were brownish-black above, and others had white spots arranged longitudinally on the back; the latter were young, as all the males had the canine teeth short.

It is solitary in its habits, and oftener seen single than in pairs. The canine teeth of the male are from 2 to 3 inches in length, and wanting in the female. The uses of these organs I have not been able to discover. The natives say they are used to dig up the roots of plants; but more likely as a means of defence, in the absence of horns. I have seen them attempt to use them when caught. It is said that during copulation the males seize the females by the ears; and, in many instances, I found these organs slit, or partly awanting, caused, it may be, by the male's sharp teeth. One spotted fawn is born in April, which remains only a short period with the parent. Bearded vultures, eagles, chetahs, ounces, &c., destroy numbers of young and old; and they are often found buried in avalanches.

Pœphagas grunniens (Linn.); *Yak*.—A few are found on the southern slopes of the Kana Korum mountains during winter, but proceed northwards as soon as the snows melt in spring. Two fine males were killed by Lieutenant Peyton, 87th Regiment, there, in March 1854. A horn of the largest size measured two feet four and a half inches around the curve, and one foot in circumference at its base; span between the points, one foot eight inches.* They are said to abound in the mountains around Yarkund.

Cervus cashmeriensis (Falc.); *Barra Singa* and *Hanglu* of the Cashmerees.—The Cashmere stag is almost confined to that country, and is seldom met with between Cashmere and Mussouree. The dense forests and fertile valleys of that beautiful country are particularly inviting to this species, as its higher ranges afford a like favoured retreat for the brown bear.

In habits and general appearances the Barra Singa bears a striking resemblance to the red deer, although it is seldom now-a-days that individuals of the latter species escape the hunter so long as to attain the size and magnitude of the Barra Singa; still I think it will be found that the horns of those killed in the Highlands of Scotland in former years are equal in size to any at present met with in the Cashmere forests. I am not at present aware that they differ in any other respect, and see no reason to think they are not one and the same species. This species is now, I believe, found identical with the *Cervus Wallichii* (Cuv.).

The adult stag averages from thirteen to fifteen hands. The colour of the coat differs but little in sex or seasons. It is dark brown above, with reddish patches on the hips; belly and lower parts whitish-brown. The males have the hair on the under part of their neck long and shaggy. The horns, of course, vary with age; the largest pair I measured were four feet round the curve, each having seven points. They are shed in March, and the new horns are not free from velvet until the end of October. When the wintry season commences, the loud "bellowings" of the stags are heard all over the mountains. They are frequently driven during rigorous winters to seek food and shelter near the villages situated in the more secluded valleys, when the natives mob them, and kill numbers with dogs. The *Felis pardus* and *Cuon primævus*, Bears, &c., are formidable enemies of the Hanglu.

The wax from the infra-orbital glands is much prized as a medicine by the Cashmerians.

Cervus muntjac (Linn.); *Barking Deer* of Europeans; *Kakur* of the natives.—Is generally distributed over the lower ranges of the western Himalayas, at elevations under 9000 feet. Prefers gentle slopes covered with wood, oak forests, &c., to bare hill-sides. Although nowhere abundant, as many as twelve may be seen in one jungle. Their movements are slow and stealthy; it is not unusual, therefore, to meet with them when least expected. By no means shy or timid; and, like the musk deer, when alarmed, starts off for a short distance, stand and gaze at the intruder, or commence to feed again. Its bark is loud and harsh, and is heard most commonly at dusk or in the morning. When running, a clattering is heard, evidently caused by the hind hoofs striking the fore ones, as in horses when they are said to "overreach."

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* The specimen of the "Yak" in the Derby Museum, Liverpool, is the largest I have seen in Britain, and may be considered a very large male.

Asinus Kiang (Moir); *Kiang* of the Ladakhees.—Is pretty common on the plains and mountains around the fresh and salt water lakes of Ladakh. Its favourite food seems to be a bent and species of Vicia with deep-red flowers, which abounds around the springs and sides of the lakes. It is oftener seen in herds than single; when started, it scampers across the plain for some distance, then turns round, and advances a few steps, as if to reconnoitre. I was informed by a Tartar that they are sometimes caught when young, and tamed, so as to be used as beasts of burden.

PROCEEDINGS OF SOCIETIES.

Papers read before the American Association for the Advancement of Science, at the Meeting held at Baltimore, May 1858.

Professor **Elias Loomis** *on the Electrical Phenomena observed in certain houses in New York.*—At the meeting of the American Association for the Advancement of Science, held at New Haven in August 1850, I gave an account of some remarkable electrical phenomena observed in certain houses in New York. That account was received at the time with some surprise; but it soon appeared that similar phenomena had been observed in a much larger number of houses than had been supposed, and every one who was at first sceptical about the facts had an opportunity of convincing himself by personal observation. At present I am not aware that there is any person in the United States who doubts the truth of the statements which I made at New Haven in 1850, or who charges them with exaggeration.

The winter of 1856–57 I spent in Berlin, and I mentioned the leading particulars of these phenomena to some of the professors of the Berlin University. They all expressed very great surprise at my statements, and some of them took no pains to conceal their incredulity. In August 1857 I attended the meeting of the British Association at Dublin, and made a short communication on the same subject to that Association. The facts were considered very remarkable, and I could not learn that anything similar had ever been observed in any part of Europe. I then decided to improve the first opportunity on my return to New York, to verify my former observations, and to procure the concurrent testimony of a second witness to corroborate my statements. The house in which my principal observations in 1850 had been made was the house of Mr D. W. Catlin, a merchant of New York, who resides in Fourteenth Street. Upon my stating the case to Mr Catlin, he gave me full liberty to make such additional observations and experiments in his house as I might desire.

The past winter has proved unusually mild, and for many weeks it seemed doubtful whether a favourable opportunity would be presented for witnessing these electrical phenomena, as it is only in extremely cold weather that they are at all remarkable. About the middle of February 1858, the first opportunity presented itself. On the morning of February 11th, the external thermometer stood at 12°; on the morning of the 12th it stood at 16°; on the morning of the 13th it stood at 18°. On the evening of the 12th, the thermometer then standing at 24°, I called at Mr Catlin's, in company with Professor Samuel St John, Professor of Chemistry in the College of Physicians and Surgeons of this city. We found the parlours at a temperature of 70°, and the electricity was quite noticeable, although by no means so abundant as at my visit in 1850. We first measured the *length* of the spark by employing two brass balls, supported on glass rods in such a manner that the distance between the balls could be regulated at pleasure. The diameter of one ball was $\frac{2}{3}$ inch, that of the other $\frac{8}{10}$ inch. When Mrs Catlin walked briskly across the room, and touched one of the balls with her finger, the other ball being in communication with the gas-pipe, the spark would not pass from one ball to the other if the distance much exceeded *one quarter* of an inch, yet this spark was quite intense, and was accompanied by a good snap. When I skipped across the room in the same manner, I gave a bright spark, but it would not pass through a distance quite as great as that furnished by Mrs Catlin.

We next attempted to light the gas from the chandelier by means of the spark. One of the burners was extinguished, and when its temperature had fallen to about blood-heat, Mrs Catlin attempted to light the gas by a spark from her finger. Three or four of the first attempts were unsuccessful; perhaps because the gas was not flowing freely at the time; perhaps because the spark passed on one side of the gas-jet. At length Mrs Catlin took a pocket-key in her hand, and skipping briskly across the room, gave a spark from the handle of the key, which ignited the gas.

We next poured a small quantity of ether into a shallow metallic cup, and attempted to ignite it by a spark from the finger. The first attempts were unsuccessful; generally because the spark was received on the side of the dish, and did not pass through the ether. After a few trials, the ether was fired by a spark from Mrs Catlin's finger.

We next received a succession of sparks upon the knob of a Leyden jar, and I received the charge through my body. The shock was sufficient to convulse my arms somewhat unpleasantly.

We next suspended a pith-ball by a silk thread, and having rubbed a stick of sealing-wax upon the carpet, electrified the pith-ball. After skipping across the room, I presented my finger to the pith-ball, and found it violently repelled, showing that the electricity of my body was of the same kind as that of the sealing-wax, which conforms to the result which I published in 1850. It should be remarked, that before commencing the present experiments, I exchanged my boots for a pair of dry slippers with thin soles.

On the evening of March 5, 1858, Professor St John and myself made a second visit to the house of Mr Catlin. The sky was free from clouds, but the stars shone somewhat dimly. The external thermometer stood at +7°. On the morning of the 5th the thermometer stood at +8°; and on the morning of the 6th at +12°. We found the temperature of

Mr Catlin's parlour 69°, and the electricity was more abundant than at our previous visit. We first measured the length of the spark by means of the same apparatus we employed in our former experiments. The balls were at a distance of one-third of an inch. I again exchanged my boots for a pair of dry slippers, and after skipping briskly across the room, and touching one of the balls with my finger, the spark passed to the other ball. I succeeded in passing a spark when the distance of the balls slightly exceeded one-third of an inch, and the spark from Mrs C.'s finger passed a little farther than my own; but even this would scarcely pass a distance of four-tenths of an inch.

We next attempted to light the gas from a burner which was quite cool. We allowed the gas to flow for a time, in order to be sure that the atmospheric air was all expelled. Professor St John then held his finger over the opening, and I took in my hand a brass rod terminated with a small ball. I skipped across the room, and applied the ball to the burner, but the gas was *not* ignited. The spark evidently passed a little on one side of the gas jet. A second trial failed, and evidently for the same reason. The third time I presented the ball to the burner with more caution, the spark passed through the gas, and *the gas was ignited.*

We next repeated the experiment with ether in a metallic cup. Professor St John held the cup in his hand, and after shuffling across the room, I presented the brass ball to the surface of the ether, but it was not ignited. A second time the experiment also failed; but the third time, after skipping a little more actively across the carpet, I succeeded in firing the ether.

What are the circumstances most favourable to the success of the preceding experiments?

1. A low temperature of the external air. I have never heard that any phenomena of this kind have been observed except during that period of the year when the houses are warmed by fires; and the phenomena are most remarkable during the coldest weather. The electricity is not abundant unless the external temperature is below 32°; and it is most abundant when the thermometer sinks to the neighbourhood of zero. I have never heard of a single fact at variance with this statement.

2. A high temperature of the interior of the house, accompanied by considerable dryness of the air. In a cold room, even when the external thermometer is at zero, but little electricity can be obtained by friction upon a carpet. A high temperature is needed, and the higher the temperature the better; and in those houses in which the electricity has been most abundant, a high temperature is preserved almost uninterruptedly during the winter season. In all my observations at Mr Catlin's house the thermometers in the parlours stood at about 70°. From all the facts which I have been able to collect, I infer that a furnace placed in the cellar, and sending its heat through flues to the parlours and other portions of the house, is more favourable to electrical excitement than any other mode of heating, whether by means of a stove or an open grate. Perhaps the only reason for this difference is, that, when a furnace is used, the entire house is more sure to be kept thoroughly warm and dry. On many of the furnaces in New York, perhaps on most of them, a dish of water is placed to supply moisture to the heated air; but it is also true, that in all the modern and well-built houses in New York, so far as

I have observed or heard, particularly in those which are warmed by furnaces, the doors and wainscot, together with the furniture, during winter habitually shrink and crack, indicating a very dry atmosphere.

3. A thick and substantial woollen carpet. My own observations and information lead me to the following conclusions:—That without a carpet the phenomena I have been describing are wholly unknown; that with an ordinary Ingrain carpet but feeble electricity is obtained; a second carpet, or a drugget spread upon the first, improves its electrical qualities. A Brussels carpet is much better than an Ingrain, and a heavy velvet carpet is decidedly the best of all. The carpet unquestionably serves as an insulator to preserve the electricity from being dissipated; and I also regard it as performing a still more important function.

4. A dry slipper, with a sole not very thick, appears to be favourable to the success of these experiments. A boot or shoe with a moist sole succeeds but poorly. Ladies are generally more successful in these experiments than gentlemen, chiefly, I think, from the fact that the soles of their shoes are ordinarily thin and dry. In my experiments at Mr Catlin's house I gave but a very feeble spark when dressed in boots; but after I had put on a pair of dry slippers, I gave a spark nearly equal to that given by Mrs Catlin. A shoe with a thin sole is preferable to a boot with a thick sole, partly because the latter is less likely to be thoroughly dry, and therefore not so well adapted to exciting electricity; and also because, even if it were perfectly dry, its great thickness would interfere with the communication of the electricity to the body as fast as it was excited.

What is the source of the electricity observed in the preceding experiments?

In my paper published in 1850, I gave it as my opinion, that the electricity was excited by the friction of a leather shoe upon a woollen carpet. I proved, by direct experiment, that by such friction electricity was actually excited; and I still believe that this is the principal, if not the only, source of the electricity. Some have thought that the electricity was due, at least in part, to the dress of the experimenter. I have satisfied myself that electricity may be excited in shuffling across a carpet by any person, no matter what his dress may be, provided only that he have shoes with a dry leather sole. Children of all ages, boys and girls, as well as persons of mature years, excite electricity in the same way. I have never heard of an individual who had tried the experiment in a house similar to that of Mr Catlin's without exciting considerable electricity. No particular material or quality of dress is essential to the success of the experiment.

It is a very common impression, and one which is countenanced by my own observations, that a silk dress is favourable to the electrical excitement. A silk dress saves the electricity which is accumulated upon the person from being dissipated as fast as it is excited; but I do not think the silk dress performs any important active part in the electrical excitement. I believe it is true that ladies generally succeed better in these experiments than gentlemen, and ladies generally succeed best when they wear a silk dress; but from the statement of Professor St John, which accompanies this paper, it appears that small boys in their ordinary woollen dress may be equally electrical; and I am inclined to think that the uniform success of ladies in these experiments is due to the fact that they are more habitually confined to the house, and their dress, particularly the shoe, is more thoroughly dry.

Some have imagined that a silk wrapper worn next to the skin was important to the success of these experiments; but this is by no means essential, for one of the most electrical cases of which we have any knowledge, was that of a boy described in Professor St John's communication, whose dress contained not a particle of silk, and who wore cotton next to his skin.

On some Electrical Phenomena witnessed in houses in the cities of New York and Cleveland, Ohio. By Professor Samuel St John.—By invitation of Professor Loomis of the New York University, I accompanied him on the evening of the 12th of February 1858, to witness some experiments on electricity, exhibited in a house in Fourteenth Street, in the city of New York. The rooms in which the experiments were performed had upon the floors thick velvet carpets, and the usual furniture of elegant houses; they are warmed by furnaces, and are kept at a nearly uniform temperature of 70° F. The experiments were performed by the gentleman and lady of the house, and Professor Loomis, who had put on dry slippers. After walking rapidly through the parlours with a shuffling motion, very bright electrical sparks were exhibited when the hand was presented to the chandeliers or other good conductors communicating with the ground. Gas was ignited at one of the burners by a spark from a key in the hand of the lady, and sulphuric ether inflamed by the spark passing from her finger to the liquid which I held in a metallic cup in electrical connection with the earth. The spark was made to pass between two small insulated brass balls, with a view to measure its length. The greatest length attained was one-fourth of an inch. The spark exhibited a beautiful appearance in a darkened room when the fingers were brought near to the wall-paper, dispersing itself through the space of a foot or more over the gilded ornaments of the paper. On the evening of the 5th of March, the coldest day of the season, the experiments were repeated in the same rooms, when a sensible increase of electrical intensity was discerned. The gas and ether were inflamed by Professor Loomis holding a brass ball in his hand, and the length of the spark attained was a little more than one-third of an inch.

These phenomena were similar to such as I often witnessed during the winters of 1854–5 at the Cleveland Female Seminary, located in the south-east quarter of the city of Cleveland, Ohio. The building is three stories high, of brick, with a sandstone basement, and is warmed by three furnaces supplied with the ordinary bituminous coal of south-eastern Ohio, the fires declining, but not becoming extinct during the night. The temperature of the rooms varied considerably, sometimes rising above 80°, but rarely falling below 60°, even during the night. The rooms in which the electrical manifestations were conspicuous were the parlours on the first floor above the basement. The floors of these rooms were covered with substantial Brussels carpets. The seasons when they attracted especial attention were periods of severely cold weather—the thermometer on one occasion indicating 23° below zero; the electrical excitement diminished in mild weather, and ceased entirely when it rained. The carpets on the halls and other rooms were thinner fabrics than Brussels carpeting, or composed partly of cotton or linen, and upon these the electrical phenomena were barely discernible. In the parlours electricity was manifested during dry, cold weather at all hours of the day, but much more strikingly in the evening, after the young ladies had spent an hour in recrèation and dancing. On such occasions the intensity of the spark was such as readily inflamed ether and pulverized resin, and measured repeatedly one-half inch, passing between insulated balls to the furnace register, which was in good electrical communication with the earth. All persons remaining in the rooms were enabled to communicate sparks to conductors, but the longest sparks were given by two boys of the ages of nine and eleven years, after running and sliding upon the carpets; this we attributed to the friction evolved by their unconstrained freedom of motion. These boys wore dry slippers, were clad in woollen, one of them wearing flannel next to his person, and the other cotton; the latter, who was of more vigorous constitution and active habits, giving the more vivid spark. A difference of electrical accumulation was also discernible among the young ladies, which we were inclined to ascribe to diversities in their dress, silk, woollen, cotton—the silk and woollen appearing more favourable to success. In one instance the different degrees of moisture upon the skin seemed to affect the amount of electricity communicated. These phenomena attracted the attention of all the inmates and visitors of the seminary; many persons expressing surprise, and some consternation, on receiving a shock, as they entered the room and took the hand presented to welcome them, preceded by a vivid spark. The passage of the spark over glass by bits of tinfoil disposed in letters, and in the "spiral tube," together with the usual experiments on electric light, were repeatedly exhibited as a source of amusement.

Tides of Saturn's Rings.—Professor Benjamin Pierce proceeded to present his paper on the tides of Saturn's Rings. It had been first shown by La Place that the ring could not be symmetrical. Pierce had proved that it could not be solid at all. He had also proved that it was impossible for it to be a group of asteroids, nor could it be fluid, unless there were satellites large enough to hold it up. Then he had found, that in order to keep the rings in existence there must be a strong tidal influence from the satellites, exactly proportioned to the circumstances of the ring. At this point the computation becomes exceedingly complicated, and Professor Pierce expressed a great doubt whether the intellect of man would ever be able to make a complete investigation of the phenomenon. The first approximation, however, is much more easily made to the theoretical tides of Saturn's rings than to the theoretical tides of our own oceans. He showed how the first approximation was obtained. The delicacy of the calculation is shown by the fact that the rings are 30,000 miles in width, and less than 250 miles in thickness. The paper was illustrated by a model of the ring. in which the thickness was relatively exaggerated, and also by careful diagrams. But little aid in these calculations can be expected from direct observations on the planet or its rings.

Dr Kane's Magnetic Observations.—Extract of the principal results of the magnetic observations of the Second Grinnell Expedition in 1853–5, at Van Rensselaer harbour and other points on the western coast of Greenland, by Elisha K. Kane, U.S.N., prepared by A. D. Bacheand Charles A. Schott.

Professor Bache had placed these observations in the hands of Mr Schott for discussion, as he had been selected for similar service by Dr Kane himself, and felt a strong interest in his work.

The results of the magnetic observations were discussed under the heads of declination, dip, and intensity. Under the head of declination, were considered: 1st, The Diurnal Range; 2d, The Diurnal Irregularity; 3d, The Disturbances of Declination; 4th, The Effect of the Aurora; 5th, The time-day Observations; 6th The Absolute Declination.

The mean diurnal range of declination was 2° 28′ 6″, and the greatest range 4° 52′ in January, February, and March 1854. These are compared with similar results of other observers in this region. But one tide appears in the diurnal change of declination, unless a very small fluctuation be admitted to represent a second one. This agrees with Captain Back's observations at Port Bowen and the Whale Fish Islands. A diagram served to show the mean changes of declination for each of the three months of observation and the average for the whole of the three. A comparison with the Greenwich curve for the same period was given.

The analysis of disturbances was made by using Pierce's criterion, which may be legitimately applied for such a purpose, and takes away the arbitrary character of the selection of observations as conforming or not to the mean. The change in discussing observations of different years at the same magnetic station, in the number adopted as bringing an observation within or carrying it without the class of regular observations, showed the desirableness of some impartial test such as is furnished by the criterion. The mean monthly disturbance for January was thirty minutes, for February sixty-five, and for March forty minutes. Deviations of one degree and thirty-eight minutes were classed by the criterion as disturbances. Twenty-three such occurred, being one in every eighteen of the observations. Eleven deflections were to the east, and twelve to the west, so that excluding the disturbances did not materially alter the mean diurnal inequality.

The time-day observations, compared with those at Washington and at Greenwich, showed no remarkable case of simultaneous disturbances.

The absolute declination at Van Renssalaer harbour, in June 1854, was 108° 12′ west.

The magnetic dip was determined at ten stations. The highest dip observed was at "Bedeirked Reach," in August 1853, and was 85° 08′.

The absolute horizontal intensity was determined by Gauss' method at those stations. The mean horizontal force in absolute measure of Rensselaer harbour was found to be 1·139 in June 1854, which gives for the total force 12·48, and in Haglugh Islands 1·344, and near Cape York 1·573, in the summer of 1855.

It is proposed to publish elsewhere all the details of these observations of which the abstract is now given to the American Association.

Phenomena of Niagara Falls—Observations made at the Falls of Niagara, September 1, 1857, by Professor JOSEPH HENRY.—On my return last summer from an excursion to the upper lakes, I arrived on the night of the 30th of August at the Eagle Hotel, near the suspension bridge, on the eastern side of the Niagara River, about two miles below the Falls, and having a day to spare, I resolved to devote a part of it to some observations on the temperature of the water above and below the cataract. These were in continuation of a few observations I had made on the upper lakes, and which appeared to have a bearing on some points of general physics of an interesting character.

On looking from my bedroom window in the morning, an object arrested my attention, and occupied it a considerable part of the day.

I observed in the direction of the Falls a series of large and well-defined cumulus clouds, evidently formed from the spray of the cataract. They ascended from the chasm in a continuous column to a considerable height, until they reached the upper current of air, and were then detached in separate masses, which assumed the regular cumulus form. The column from which these clouds were detached ascended to a great elevation; for I was informed by an intelligent gentleman at the place, that it is sometimes seen on Lake Erie at a distance of 70 or 80 miles, which would give it an elevation of about 4000 feet.

This height would be sufficient to explain a phenomenon which was also mentioned to me of electrical flashes sometimes being seen in this column, and that the detached masses of vapour blown from its top were in some states of the atmosphere transformed as it were into real thunder-clouds. If we admit that the earth is highly negative, and the column a partial conductor, the vapour should become intensely charged with electricity at its upper extremity, since this is a high salient point from the surface of a charged globe.. The electrical phenomena of the Falls deserve to be studied with much attention, since they afford the means of settling principles connected with the production of vapour of much interest in regard to the physical phenomena of the earth.

The nature of this column, which ascends from the cataract, is an interesting question, which would well repay more attentive investigation than my time or opportunity would permit. The lower part is principally, if not entirely, formed of minute globules of water not vesicular, since they decompose light and produce the rainbow constantly visible during sunshine. These globules can be seen with the naked eye, of various sizes, exhibiting brilliant prismatic colours even close to the face of the spectator. The upper part of the column is incapable of producing the decomposition of light except in a very feeble degree, which may result either from the extreme fineness of the particles, or from their vesicular constitution.

I have never become fully satisfied as to the existence of this vesicular state, but perhaps I have been prejudiced in reference to it, from the fact that I have never been able to conceive of any known cause of action which would lead to the formation and continuance of such an arrangement of particles. I may mention, however, one observation which might seem to favour the spontaneous assumption of such a form. When a soap-bubble bursts, it frequently resolves itself into a number of very minute vesicles, and the positive assertion of Saussure, that hollow spherules do really exist in clouds on the side of mountains, ought to outweigh a large amount of negative testimony.

But to return to the column of vapour. There are two suppositions in regard to it,— one that it consists entirely of particles of water such as are in the lower part of the column, but growing more minute as we ascend toward the top of the column, and the other that the upper portion is formed of vapour which has been evaporated from the surface of the larger spherules, and subsequently condensed into visible clouds by the diminution of temperature as we ascend in the atmosphere. If the latter supposition be true, at first sight we might suppose that the quantity of vapour formed would be greater when the dew-point was very low, though the absorption of heat by the evaporation would partly compensate for this. In still weather a high local dew-point probably exists around the Falls, and the quantity of vapour which constantly arises from evaporation, would be very much diminished by the cold, were there not a source of constant supply of heat, and this apparently may be found in the concussion of the water itself.

It is well known from the experiments of Jule, the investigations of Clausius, Rankin, Thompson, and others, that the agitation of water or of any other liquid evolves heat. Jule has found that the mechanical energy generated by the fall of a one-pound weight through 750 feet is sufficient to produce a rise of temperature of 1° of Fahrenheit's scale in a pound of water.

It appears from a series of measurements made by my friend Z. Allen, of Providence, Rhode Island, some years ago, and published in "Silliman's Journal," that 701,250 tons, or upwards of fourteen hundred millions of pounds of water are precipitated over the great cataract of Niagara during every minute of time, thus acquiring a mechanical energy greater than the estimated steam power now in use in all the civilized world. This energy, however, is not alone expended in generating heat; a portion of it is absorbed in wearing away the rocks, and in excavating the gorge in which the water flows. Another portion is absorbed in producing a tremor in the earth and in the air; also currents in the atmosphere and in the water below the Falls; another in compensating for the loss of rotatory power of the whole earth in the ascent of the particles from the ocean. A greater portion, however, is probably expended in producing the vapour in the constantly ascending column which we have before described.

The principal object of my investigations at the Falls was to ascertain whether there was any difference in the temperature of the water above and below the cataract. Unfortunately I was not provided with very sensitive instruments, and was obliged to make the observations with two thermometers, which I selected from a number found in the shop of a watchmaker at the village near the bridge. The two gave the same indications; and although the actual graduation could not be depended upon, still they served to show differences of temperature with as much precision as the length of degrees on the scale would permit.

The temperature of the air above the Falls was 71½°, and about the same below. At the latter place it however partook of the temperature of the spray with which the air was filled where the observation was noted.

The temperature of the water was taken above the Falls from the eastern edge, near the head of the staircase, from the race-way, near the bridge across the rapids, from about the middle of the bridge itself, from the eastern shore of Goat Island, and from the foot of the tower at the very verge of the precipice. Several observations were made at each place, which did not differ from each other more than a tenth of a degree. The average temperature thus obtained was 69°. I was surprised to find a temperature so high and so uniform, since the day previous (the 30th of August) I had found the temperature in the steamboat channel of Lake Huron 57°. This increase of temperature was probably due to the passage of the water through the broad, shallow basin of Lake Erie. The uniformity of temperature at different points along the Falls was probably caused by the mingling of the water in passing through the narrow straits at Detroit, and over the rapids of Niagara River. The result was, however, unexpected, since I had observed in Lake Superior considerable variation in the temperature of water at different points, indicating currents of different temperatures. The absorption of so much heat during the passage through Lake Erie must materially influence the climate on the shores of that body of water.

Observations were next made below the Falls, and for the opportunity of making these I was indebted to the kindness of the captain of the small steamboat "The Maid of the Mist." The temperature was noted as near the perpendicular fall as could be approached from the deck of the steamboat amidst the spray, at intervals, for a considerable distance across the river. The results agreed among themselves, and the average gave almost precisely the same temperature as that which had been found above. I regret that the thermometers employed were not more sensitive, though I am confident that on this occasion the temperature above and below the Falls did not differ more than a fifth of a degree, if as much.

On reflection, it would appear that, though an immense amount of heat may be evolved by the mechanical energy of the cataract, yet the quantity of water to be heated is commensurate with the increase of temperature produced; and if we estimate the height of the fall at 160 feet, this will give an elevation of temperature for every pound of water of about one-fourth of a degree. The difference of observed temperature is less than this amount, and the excess was probably expended principally in producing the constant formation of the clouds before described. All these observations were made in the course of about six hours, and though they may not establish definitely any important fact, yet they may serve to indicate a line of interesting investigation in regard to the phenomena presented in unparalled magnitude in this cataract.

It would, for example, be desirable to ascertain the form and dimensions of the wave of tremor propagated through the earth by the concussion of the water, which might perhaps be ascertained by the agitation observed on a surface of mercury. The nature of the vibration of the air under the falls should also be determined.

Besides the electrical condition of the spray, the column, and of the clouds which are formed from its top, the electrical equilibrium of the earth in the vicinity of the Falls may be in a state of instability—a fact which might perhaps be determined by connecting the telegraph wires with the water above and below the cataract. Other points which would undoubtedly arise in the course of an investigation of this character might profitably occupy a few weeks of the time of the scientific visitor to this world-renowned exhibition of the stupendous energies of nature.

Ichnology of New England.—Professor HITCHCOCK read a very interesting paper on "the Ichnology of New England," describing and classifying animals not now in existence, but whose tracks have been found in the rocks of New England, principally in the valley of the Connecticut river, in a sandstone interstratified with shale, which has been variously classified by geologists.

The author stated that it was not his object to give the elementary principles of Ichnology, or the Science of Fossil Footmarks, but only to state its present condition as far as New England is concerned. He had just made a report to the government of Massachusetts on the subject, which is now in course of publication, the plates of which, sixty in number, were suspended in the hall.

He called the animals that made the tracks *Lithicknozoa*, or stony-track animals, and to these he had given names.

The rock containing the tracks in the Connecticut Valley, the most prolific of all known localities, he gave his reasons for supposing to form the lower part of the oolitic or jurassic system, say the Lias.

The trough containing the tracks is about ninety miles long and two or three broad, and the thickness of the rock containing the tracks, in one or two places, 3000 to 4000 feet.

The author arranged the Lithicknozoa under the following groups, having premised that, like the well-known lizards and other animals whose bones occur in the Lias, these tracks discovered animals probably possessed of characters now found distributed among several families :—

Group 1—Marsupialoid Animals; 3 genera and 5 species.
Group 2—Thick-toed Birds; 3 genera and 14 species.
Group 3—Narrow-toed Birds; 4 genera and 16 species.
Group 4—Ornithoid Lizards or Batrachians; 7 genera and 12 species.
Group 5—Lizard; 11 genera and 17 species.
Group 6—Batrachians; 10 genera and 16 species.
Group 7—Chelonians; 5 genera and 8 species.
Group 8—Fishes; 1 genera and 4 species.
Group 9—Crustaceans, Myriapods, and Insects; 10 genera and 18 species.
Group 10—Annelids; 6 genera and 10 species.

Drawings of the natural size of the tracks of all these species were shown on cloth, exhibiting the form and position of the feet, and the length of the step.

SUMMARY.

Number of localities,	38
Number of species in the Connecticut Valley,	119
Bipeds,	31
Quadrupeds,	55
With more than four feet,	18
Without proper feet,	12
With an uncertain number,	3
Marsupialoids,	5
Thick-toed birds,	14

Narrow-toed birds,	17
Ornithoid Lizards or Batrachians,	10
Lizards,	17
Batrachians,	11
Chelonians,	8
Fishes,	4
Crustaceans, Myriapods, and Insects,	18
Annelids,	8
Of uncertain place,	6

Much uncertainty rests upon some of these conclusions, but making every allowance, we have here revealed a remarkable Fauna of the Red Sandstone days.

On the Rocks of Kansas. By Professor SWALLOW, State Geologist of Missouri.—The object of this paper was, to prove the existence of Permian rocks in Kansas identical with the formations of that name in Great Britain and Russia. Professor Swallow remarked,—

"I presented a map of Kansas last year at Montreal, a part of which was coloured according to my own conclusions, derived from personal observations; other parts according to other geologists, but mostly I followed the conclusions of Major Hawn. At that time I had seen no fossils from Central Kansas. The fossils collected by Major Hawn settle the rocks in part only—Coal Measures, Permian, and Cretaceous. We have not sufficient evidence to settle the beds between the Cretaceous and Permian. We have but few fossils, and they have various affinities—some to the Triassic, some to the Liassic, and others to the Jurassic. I am indebted to Major Hawn for a large part of the information presented in this map and section of the rocks of Kansas.

"The following section gives the rocks of Kansas as given by Major Hawn:—

No. 1.—200 feet Quaternary.
No. 2.—75 feet Cretaceous.
No. 3.—420 feet Triassic.
No. 4.—820 feet Permian.
No. 5.—1070 feet Coal Measures.
No. 6.—170 feet Mountain Limestone.

"The Quaternary deposits are similar to those rocks in Missouri, and the Cretaceous affords no new features. The Triassic is a very interesting group of sandstones, limestones, clays, marls, and gypsum. But few imperfect fossils have been observed. They resemble both the Triassic and Liassic forms. The upper Permian is made up of nearly the same as the doubtful beds above. They abound in fossils of well-known Permian types. *Monotis*, *Schizodus*, *Bakevella*, *Synocladia*, *Thamniscus*, &c., some twenty species. But one known Carboniferous fossil was observed—the *Terebratula subtilita.* The lower Permian contains fifty-seven species of Permian fossils, and fifteen species of Carboniferous. Although the Permian species are so much the more numerous, the individuals of the Carboniferous types are much more abundant, about as ten to one to the Permian forms.

"Among these Permian fossils I have identified fifteen European species, and described thirty-four new ones. Mr Meek has described ten.

"In an economical point of view, these Permian beds are very important. The gypsum they contain will enable the farmer to convert the vast sandy plains of Central Kansas into the most productive regions of the west. It will also supply the commercial demands of the Mississippi valley, which are now met by importation. There has been some misunderstanding in relation to the Permian fossils of Kansas. This has all arisen, as I apprehend, from a misunderstanding of the arrangements between Major Hawn and Mr Meek. It may be proper to state in this place, where all the parties interested are represented, the facts as they exist. Since the first announcement of the discovery of Permian rocks in Kansas, in the March number of the "Journal of Science," several communications have appeared in rapid succession, disclosing the existence of that formation in various parts of the west. My paper, declaring the discovery of several well-known Permian fossils in the valley of the Cotton-wood, in Kansas, was read in the St Louis Academy of Science on the 22d of February. On the 2d of March, Messrs Meek and Hayden announced the discovery of Permian fossils, by Major Hawn, on the Smoky Hill Fork, in Kansas, and by Dr Cooper, near Hilena in the same territory, in the Albany Institute. On the same day their announcement was read in the Academy of Natural Sciences at Philadelphia. On the 8th of March, Dr B. F. Shumard announced the discovery of Permian rocks by Dr G. G. Shumard, in the Guadaloupe Mountains, in New Mexico. Dr Norwood's letter, showing the existence of Permian rocks in Burean, La Salle and Henry counties, in Illinois, was read in the St Louis Academy, on the 5th of April. On May of 1857 Mr Worthen placed in Professor Hall's hands fossils supposed to be Carboniferous, but which proved to be, on comparison, of Permian types. It is but just to state in this connection, that, so far as I know, Mr Meek first discovered the Permian character of the Kansas fossils, and communicated to Major Hawn his impressions on the 3d of September 1857. He also mentioned his discovery to some friends at the Smithsonian Institute, on the 17th of January 1858, and communicated the same to Professor Leidy on the 16th of March. Major Hawn frankly declares his first impressions that the rocks in question are Permian are due to Mr Meek."

Mr A. H. WORTHEN *on the Permian Rocks of Southern Illinois.*—He said:—"I only desire at the present time to announce to the Section the discovery, in Gallatin county, Illinois, of beds equivalent to the Permian formation of Europe, and to present, as an evidence of the fact, a few of the fossils which have been obtained at the locality. These fossils were obtained from a thin band of iron ore not more than four or five inches in thickness, which has been found outcroping, at a single locality only, in the bed of the north fork of Salim River. This band of iron ore is overlaid by from forty to fifty feet of micaceous sandstones and shales, in no respect different in their lithological characters from similar beds of the Coal Measures with which they are associated. These beds were discovered, and the fossils collected, by Dr Norwood and myself in the summer of 1852, while engaged in the geological survey of the State. These fossils were determined by the Palæontologists of the survey, Dr Norwood and Mr Pratten, to belong to the Coal Measures, and they were so labelled and placed in the drawers of the State collection, where they have remained up to the present time.

"So exactly similar are these beds in their lithological characters with those of the Coal Measures, that it is quite impossible, in the absence of fossils, to determine where the beds belong; and in Kansas, according to Professor Swallow's paper. it is quite difficult, from the blending together of the fossils of the two formations, to determine exactly where the Carboniferous ends and the Permian begins.

"From these facts the query has been suggested to my mind whether the so-called Permian system of Europe is not really a part of the Carboniferous system, which is represented in this country by what we term the upper Coal Measures, which contain very few productive coal seams, but abound in argillaceous limestones and shales teeming with the remains of marine organic life."

Professor Swallow was gratified to see these fossils. The locality from which they came is the fourth in Southern Illinois, in which such fossils have been found. In reply to some remarks by Dr Hall, Professor Swallow saw that the greater number of *species* found are Carboniferous, though the larger number of individuals are Permian.

Professor H. Rogers thought that a most important fact in showing the continuity of the formation.

Dr Hall contended at some length that the Carboniferous and Permian formations graduated into each other, and could not be considered as separate systems.

Professor H. Rogers was glad to hear the admission of the slenderness of the proof on which rested the opinion that the two are separate systems. He urged upon the section that great caution should be used in following European nomenclature, and that American geologists should give the nomenclature for American geology.

Botanical Society of Edinburgh.

Thursday 10*th June*, 1858.—Dr SELLER, President, in the Chair.

Dr Balfour called the attention of the Society to the death of Dr James Barnston, Professor of Botany in the University of M'Gill College, Montreal, who was for several years an active member of the Society, and who died on 20th May last.

The following communications were read:—

1. *Notes in regard to the Production of Forked Varieties of Ferns from Spores.* Illustrated by Plants and Specimens. By Professor BALFOUR.

The term spore, as used by botanical authors, has different meanings. It is applied to the small cellular body produced by a direct process of reproduction,—*i.e.*, by the contact of antheridian and pistillidian cells or their contents,—as well to a cellular body produced in certain parts of plants without the influence of reproductive organs. Each of these kinds of spores, when placed in favourable circumstances, germinates, and gives origin to an independent plant or vegetable organism.

As an example of the first kind of spore, we may take that of Confervæ, in which conjugation takes place. As the result of this process, a cellular germinating body is at once produced. Sometimes the cell has cilia, and moves about until it reaches some spot in which it becomes fixed, and then sprouts. The same kind of spore is common in sea-weeds, some of which are monœcious or diœcious. In these the contact of the spermatozoids from the antheridian cells, and the archegonial cell of the pistillidium, gives origin to a germinating spore, which forms at once a new plant, bearing, like its parent or parents, antheridia and pistillidia. In the case, however, of the higher Cryptogams, as ferns and mosses, and their allies, the archegonium produces a cell which, after contact with spermatozoids, becomes a spore, which germinates and produces a plant bearing other kinds of sporoid bodies, which are contained in sporangia or cases, and which become finally detached from the plants. When placed in favourable condition, these separable spores or sporoid cells sprout and produce, not the ordinary plant, but a peculiar cellular expansion or prothallus, either external or internal, which bears upon its surface antheridian and archegonial cells, or proper reproductive organs. An impregnated archegonial cell of the prothallus then produces the plant in its ordinary form. These spores, when taken from forking or crisp varieties of ferns, seem to have a remarkable tendency to keep up the variations present in the plants whence they have been taken.

Mr M'Nab has noticed that the forked variety of ferns are easily propagated in this way. He finds that the spores almost invariably produce these varieties; and he has no difficulty in keeping up a stock of these abnormal forms. These spores would thus appear rather to resemble the buds of higher plants, which keep up varieties more certainly than seeds do. The spores of these varieties of ferns, in a wild state, do not seem to propagate similar ferns readily; for such varieties are comparatively rare in a native condition. Yet it would appear that when grown in the garden they are abundantly produced from spores.

A point in regard to the fern spores requires attention, and that is, that they do not at once produce a frond bearing similar spores, but they pass through a prothalloid stage with antheridia and archegonia, and after impregnation the archegonial cell produces the sporiferous frond. Here, then, the analogy with buds will not hold, for the sporoid bud passes through a reproductive stage before producing the frond.

But a question arises, is it necessary that a sporiferous frond must pass through this reproductive stage? It would appear not, for in a tree fern, while there is produced at first a prothallus with reproductive organs, yet this is not the case subsequently. It would appear, therefore, that sporiferous fronds may continue to be regularly produced without any evident direct impregnation.

Some, however, may be disposed to take the view, that when once an archegonial cell has been impregnated, its influence may extend through successive generations, while others may say that these spores, which are not the direct product of organs of reproduction, may be analogous to parthenogenetic seeds, or embryos produced without any contact of pollen; in fact, that they are germinating cells, which require no influence from the antheridia, and are therefore developed by a true process of parthenogenesis.

On such a supposition, a tree fern, produced from a spore at first, and passing through a prothalloid stage, with organs of reproduction, continues to produce ever afterwards parthenogenetic spores or cells. Such cells may have a tendency to propagate particular forms of plants, just as is the case in the *Cœlobogyne*, where female plants have always been produced from seeds not acted on by pollen. In this way we may account for the spores of these fully-developed anomalous ferns always producing varieties like their parents.

The subject is a curious one, and well worthy of further investigation. The experiments of Mr M'Nab are remarkable, and deserve to be recorded. What we want to know is:—

1. Is a sporiferous frond produced without a previous archegonial stage?

2. Is there anything peculiar in the structure of the spores in the sporangia of ferns, and more especially in those of the anomalous forked ferns to which we have referred?

3. Do the spores, when produced on the first frond, directly proceeding from the archegonial cell, differ from those produced on subsequent fronds?

4. Have the spores in the first frond the same tendency to reproduce these marked varieties as those on subsequent fronds without a prothallus?

5. Do these spores exhibit anything analogous to parthenogenesis in the higher orders of plants?

For one who has the patience to investigate the matter, there is an interesting field open. It requires that the observer should examine spores, prothalli, with their antheridia, and archegonia, microscopically in all stages, and that he should have the means of growing these spores under his eye, so as to watch their development in all stages. To any who may wish to undertake such an investigation, the resources at hand in the Botanic Garden will be fully laid open, and all assistance will be given in the investigation. Mr M'Nab has led the way in this interesting cultivation of fern varieties, and he is able and ready to impart fully the result of his observations. On the table are displayed a series of interesting forms of ferns, which he has now cultivated for many years.

In connection with the subject of the production of ferns from spores, Mr M'Nab remarked, that it was of great importance to collect the spores properly. He stated that where a number of ferns are growing together, and the spores are allowed to ripen, they seem to spread about in a remarkable way, and to be attracted by the sporangiferous fronds of the ferns around. Thus, he collected spores for two years from the ripe sporangiferous fronds of *Osmunda cinnamomea*, and on sowing them, under bell-glasses, there came up crops of *Polypodium Dryopteris*, and nothing else. So also, spores from the sporangiferous fronds of *Anemia fraxinifolia* for two years gave rise to crops of *Polypodium cæspitosum*; and the spores collected from the ripe sporangiferous fronds of *Darea diversifolia* produced a crop of *Blechnum braziliense*. Mr M'Nab remarked that the spores of the above were matured on the plants, and were growing along with many other species in the neighbourhood of the kinds produced. Spores of the above species taken from plants in a young state, and ripened in a book carried in the pocket, have now come true. In order, therefore, that the spores may produce the species or variety wanted, it seems necessary to collect them in a young state, and to take care that the spores of other ferns do not come into contact with the fronds.

2. *On M. S. De Luca's Claim to be the Discoverer of the Non-presence of Iodine in the Atmosphere, in Rain-Water, and in Snow.* By Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Edinburgh.

(This paper appears in the number of this Journal for July 1858.)

3. *Recent Additions to the Cryptogamic Flora of Edinburgh.* By W. Nichol, M.D.

4. *Botanical Notices.* By Professor Balfour.

1. *Qualities of* Hieracium virosum.

The following notes have been supplied by Dr Christison:—

"There are some poisonous species among the *Cichoriaceæ*. Among them may be mentioned the *Hieracium virosum*, Pall., which is often mistaken for *H. sabaudum*, and more especially *Crepis lacera*. (Tenore, Flora Neap. ii., p. 179, tab. 79, et ejusdem Syn., p. 402. DC. Prod. vii. 161.)

"Tenore says of this *Crepis*, in his Synopsis, p. 403:—'Venenatissima planta lacte maximè acri scabens; eademque, cum aliis sponte nascentibus Cichoreis, ad juscula conficienda lecta, sæpe illa comedentes miserrimè necavit.'

"Von Martens, in his 'Italien,' informs us respecting this plant:—'The *Angina* of the Neapolitans, called in the Abruzzi *Castellone*, constantly grows near calcareous rocks, and abundantly in the lower forest districts of the Apennines, from the Abruzzi to Calabria, especially on Gargano, where Micheli (Hortus Pisan., p. 81) represents it as an herb which kills pigs; also on the mountains of Caserta, Anienza, &c. The leaves resemble those of the dandelion, the chicory, and other species of the same family, which are much used by the country people as food; and as these plants are all used in spring before they flower, mistakes are easily committed, and poisoning with the *Angina* is consequently not uncommon. Gussone pointed it out to me on Mount St Angela, above Castellamare, near Naples, at an elevation of 2500 feet, and mentioned an instance of poisoning of a whole family by it. The mother and children died in fearful tortures, and the husband alone recovered. On 21st July it was in full flower, and was then easily known by its tuft of gold-yellow flowers, and the mealy bloom which covered particularly the upper part of the plant, giving it a grayish-white appearance. When recognised in this state, the information is spread from mouth to mouth, so that the chicory gatherers may avoid in spring the places in which the *Angina* has been seen during the previous summer.' (Schultz, in Buchner's 'Repertorium für Pharmacie,' 1853, ii. 77, from 'Bonplandia,' i. 4.)"

2. *Boethius' Notice of* Solatrum amentiale, *and its effects on the troops of the King of Norway.*

Boethius, in his "Historia Scotorum," says, "When Sueno, king of Norway, saw his brother add England to his Danish kingdom, he wished to equal his brother in glory and in empire. Accordingly, he came with an army to Scotland, alleging as a cause of war his desire to revenge the slaughter of his relative Carnus, and of other Danes slain with him at Barre, Crowdane, and Gemmere. But though Sueno came, as it is said, with the view of acquiring fame and honour, yet he was not to be compared to his brother Canute; for he slew innocent children, women, and aged persons. When King Duncan heard of these shameful cruelties committed on his people, he felt called upon to prepare himself for battle. He assembled a large army, and divided it into three parts; the first battalion was given in charge to Macbeth; the second to Banquho; and he commanded the third himself, taking with him the greater part of the nobility. The armies of Duncan and Sueno met at Culross, not far from the place where the abbey of the Cistercian monks afterwards was built. The battle was carried on with great vigour, and with immense slaughter, on both sides. The Scots were defeated, and put to flight. The Danes, however, were so fatigued and broken up that they were unable to pursue their enemies, and they remained on the spot all night under cover. Next day, perceiving that the tents had disappeared, they fell upon the booty which had been left. At the same time, an order was given that no injury should be done to any unarmed person. In this way they hoped to conciliate the people, and make them declare in their favour. After this, Sueno pursued Duncan with his whole army. Having learned that King Duncan had fled to the Castle of Bertha, and that Macbeth was gathering fresh forces to resist his incursions, he laid siege to the said castle.

When Duncan saw himself surrounded on all sides by enemies, and after having been closely beset for eight days, he sent, by advice of Banquho, a second messenger to Macbeth, commanding him to remain at Inchecuthill until further notice. At the same time, he despatched a herald to Sueno, with a request that he would allow him and his nobles to depart from the castle with their lives and fortune. Duncan made the request, although he knew it would be refused, with the view of making his enemies suppose that the castle would be given up without any further delay. Accordingly, having sent a messenger, he desired that Sueno would send a commissioner to the city, in order to arrange the terms of surrender. When he came, Duncan pretended that he did not wish to offer further resistance to Sueno, and that he was ready to give up the citadel. At the same time, in order to conciliate Sueno, and to cause a little delay, he promised to send a large quantity of provisions for the use of his army, in the shape of wine, beer, and corn. This offer pleased Sueno and his army, for they were in great want of fresh provisions, in consequence of the cattle and grain having been previously taken away to fortified places by the Scots. Before transmitting the provisions the Scots mixed the wine and beer with the juice of the maddening Solatrum (*Solatrum amentiale*). This is described as "Herba est ingentis quantitatis, acinos principio virides, ac mox ubi maturuerint purpureos et ad nigredinem vergentes habens, ad caulem enatos, sub foliis latentes, seque quasi retrahentes, vimque soporiferam, aut in amentiam agendi si affatim sumpseris habentes, magna ubertate in Scotia proveniens." An herb of great size, bearing berries, at first green, and, when ripe, purple, or verging to black, attached closely to the stem, and concealed under the leaves, as it were withdrawing themselves; possessing a soporific power, and driving to madness if taken largely; attaining great luxuriance in Scotland. Sueno and his soldiers eagerly partook of this poisoned wine and beer, and swallowed them in large quantities. Accordingly, they soon fell into a profound comatose sleep. In the meantime, Duncan sent a faithful messenger to Macbeth, telling him to come immediately with his army as the enemy were an easy prey. Macbeth accordingly having crossed the Tay, led his army to Bertha, and going out by the gate opposite to the position occupied by the Nórwegians, under the guidance of Banquho, he reached the camp of the enemy. Then raising a loud cry, in order to ascertain if any of the enemy were awake or sober, they proceeded to slaughter their foes. The greater part, involved in deep sleep, were murdered in their beds. Some, driven to madness, did not understand what they did, or what was being done by their enemies. Some who had suspected the enemies' gifts, and had been kept free of the drug, ran to the king and endeavoured to rouse him, but finding that all was in vain, they carried him bodily during the night to the mouth of the Tay, where their ships were, and setting sail, proceeded to Norway. Thus the Norwegian army was destroyed. None escaped except Sueno, and those persons who were with him, along with the sailors. It is said that for many years afterwards all who were made knights in Norway were sworn to revenge the slaughter of their friends in Scotland. The other Danish ships which were left in the Scottish Firth were afterwards sunk by the violence of an east wind.

The question to be solved is, what is this *Solatrum* mentioned by Boethius. Bellenden, in his translation of Hector Boece's work, calls it *Mekilwurt*. It appears to be *Atropa Belladonna*, judging by the characters of the fruit, &c., as they are given in the original. This plant is not very common in Scotland at the present day. It is found, however, near old castles, where it seems to have been cultivated for medicinal purposes. Not very far from Culross, in Fife, there is abundance of it.

5. *Notes on* Muscari latifolium *of Dr Kirk.* By Maxwell T. Masters, Esq. Communicated by Professor Balfour.

6. *Remarks on* Daltonia (Cryphæa) Lamyana, *Montag.* By M. Montagne.

Dr Balfour read an extract from a letter from M. Montagne, dated Paris, 28th May 1858, in which he observes that he had read in a late number of the "Annals and Magazine of Natural History," a report of the proceedings of the Botanical Society, in which it is stated that Dr Lawson had noticed the discovery in Britain of Montagne's *Daltonia* (*Cryphæa*) *Lamyana*, but that owing to the want of an original specimen there was some difficulty in determining the identity of the two names, and of ascertaining the connections of the species.

M. Montagne therefore states, that with the view of shewing his sense of the honour which the Society conferred upon him by electing him a foreign honorary member, he has sent, in a letter, an authentic specimen of the Limoges Moss in order that it may be submitted to Dr Lawson for his opinion, and for comparison with British specimens.

M. Montagne then refers to his paper in the "Annales des Sciences," where the moss has been described, and gives the characters of the species.

It appears that Bruch and Schimper consider the plant as only an aquatic variety of *Daltonia heteromalla.*

7. *Remarks on M. Montagne's Specimen of* Cryphæa Lamyana. By George Lawson, Ph.D.

Dr Lawson stated that he had carefully examined the specimen above referred to, which M. Montagne had so kindly sent, and that he had compared it with the series of examples of *C. heteromalla* in the University Herbarium. There seems to be no doubt whatever that the specimen collected by the Rev. C. A. Johns, in the River Taw, belongs to the form named *C. Lamyana* by M. Montagne. Whether that is a good species is another question. Dr Lawson's examination has led him to the conclusion that it is not. M. Montagne refers especially to these characters as the most obvious ones of his species: "Foliis obtusiusculus (non acutis), perichætialibus dentatis (haud integris), operculo conico-incurvo (non acuminato recto)." Now the Limoges specimen exhibits leaves which are acute, the perichætial leaves are mostly entire, and the operculum, while short, conical, and incurved in some examples, is much elongated, acuminate, and quite straight and erect in others. The fact seems to be, that *Cryphæa heteromalla* is subject to considerable variation with respect to these characters, and that *C. Lamyana* cannot be satisfactorily separated as a species. It must be kept in view, however, that the form is a very distinct one as regards habit and habitat. Instead of growing on the trunks of trees like the usual state of *C. heteromalla*, it is submerged and attached to stones, and exhibits all the appearance of a true aquatic moss. It is very robust, and is of a less vivid hue than the normal form. Bruch, Schimper, and Gümbel in the "Bryologia Europæa," Müller in his "General Synopsis," Wilson in the "Bryologia Britannica," Stark in the popular "History of British Mosses," and other recent writers, have ranked the plant as a variety, under the name *aquatilis;* but Schimper, in his most recent work, the "Corollarium Bryologiæ Europæa," omits all mention of it; and, moreover, in his revised character of the genus *Cryphæa* (p. 98), uses the expression "habitatio arborea," which is quite at variance with M. Montagne's plant. The form is so distinct as a variety that it ought not to be overlooked, nor should the name given to it by M. Montagne be discarded. Dr Lawson therefore proposed that it should in future be recognised by botanists as *Cryphæa heteromalla, β. Lamyana.* Much praise is due to M. Montagne for the frank manner in which he has facilitated an examination of the claims of his plant to specific distinction, and it is to be hoped that the authors of doubtful species will more generally follow his example.

Dr Lawson placed in the collections at the Royal Botanic Garden, a series of microscopical preparations, showing the characters above alluded to in M. Montagne's plant, along with the specimen which that gentleman had presented to the Herbarium.

Thursday, 8*th July* 1858.—Dr Seller, President, in the Chair.

The following Papers were read :—

1. *Biographical Sketch of the late Robert Brown.* By Professor Balfour.

(This paper appears in the present number of this Journal.)

2. *Notice of the Palm-House in the Royal Botanic Garden at Edinburgh.* By Professor Balfour.

The Botanic Garden has always had a most important connection with the University of Edinburgh, although it does not form a part of that institution. In all stages of its existence, whether as the Physic Garden in the centre of the city, or in its position at Leith Walk, or in its present site, it has been associated with the Chair of Botany, and the University course of lectures has been conducted more or less completely within its precincts. Thus, from the time of its foundation, in 1670, up to the present day, the garden has contributed in no small degree to the cause of botanical education. The value of the instruction in botany, given in this University, has thus been materially enhanced. The student has facilities of becoming practically acquainted with plants, which are not afforded by any other school in Britain. And it is satisfactory to know, that from the Edinburgh University there have been sent forth men who have occupied most distinguished positions in the botanical world in this and in other countries ; and that, at the present moment, applications are often made to us for medical men to fill the situation of botanists and naturalists in scientific expeditions. Dr Balfour Baikie, who is now conducting so successfully the Niger expedition ; Dr John Kirk, who is associated with Livingstone in the exploration of Central Africa ; and Dr Hector, who acts as naturalist in Palliser's North American expedition, are all distinguished graduates of this University. Much of our scientific fame is thus necessarily connected with our excellent garden.

In its early condition, there do not appear to have been any houses for the cultivation of plants from hot climates. In the Catalogue published by Sutherland in the year 1683, no notice is taken of such plants. Such houses were, however, subsequently added, more particularly when the garden was removed to Leith Walk.

In a description of the garden at Leith Walk, it is stated that the soil was light, either sandy or gravelly. In the centre of the garden, a spring of water was formed into a basin. In the east division there was a systematic arrangement of plants. On each side of this area were placed officinal plants, with trees and shrubs. This division contained about 2000 species. In the west division there was a collection of tender plants and of hardy trees properly arranged. The conservatories formed a front of 140 feet, consisting of a greenhouse in the centre, and a hothouse at each end. They were said to be too small for the collection in 1788.

Among the plants mentioned as deserving attention were *Illicium anisatum*, the star anise ; *Musa sapientum*, the banana, which produced ripe fruit ; a number of Abyssinian plants, and the moving plant of India (*Burrum chundalli*). All these required the protection of hothouses. The extent of glass houses, however, was not great, and there was no house for the cultivation of large palms and the loftier exotics of warm countries.

When the present site was occupied by the garden in the year 1820, Dr Graham, my predecessor in the chair of botany, persuaded the Government to increase the hothouse accommodation. A considerable sum was expended on the erection of suitable buildings, and from time to time additions were made.

In 1834, a large palm-house was added, which cost about L.1500. It was intended at first that this building should occupy the vacant space in the centre of the front range, but from a fear that it would encroach too much on the present walk, and might possibly cast too great a shade on the contiguous houses, a site was chosen for it behind the buildings then in existence. Here a house of an octagonal form was erected; the length from east to west, and from north to south, being nearly 60 feet. The sides are 27 feet high, formed of stone pillars set upon a continuous base, and connected at the top with stone lintels, the spaces between the pillars being filled up with glazed wooden sashes. The roof, which is of wooden rafters, is covered with glazed sashes, and is of a conical form, rising to the height of 20 feet above the sides, making in all a height of 47 feet from the floor to the apex of the root.

At the time of its construction, it was, I believe, the largest palm-house in the kingdom. The heating was at first effected partly by steam and partly by hot water. Subsequently, however, hot water alone was used. There were two cast-iron boilers, with distinct arrangements of cast-iron pipes attached to each, so that one or both might be used as required. The boilers and pipes were renewed about the years 1847–48. This palm-house was found to be admirably fitted for the growth of palms, and, under the judicious management of Mr William M'Nab, it acquired great celebrity. The plan of construction was found so successful, that it has been followed by Mr Matheson in the recent magnificent addition to the building.

In course of time the palms outgrew the house. Several of them, such as *Caryota urens* and *Sagus Rumphii*, sent their leaves through the roof; and a noble specimen of the former, about 41 feet high, had to be turned out into the open ground, where it was an object of interest during the meeting of the British Association in August 1852, and astonished a famous Italian Professor of Botany, Parlatore, who, not knowing the history of its transplantation, was led at first to entertain a very favourable impression of the warmth of our climate. The palm of course died as the cold weather of October approached. Other palms in the house were materially injured by overcrowding. Among them might be noticed particularly *Acrocomia aculeata*, *Livistona chinensis*, and *Sabal umbraculifera*. These circumstances led me to apply for an addition to the palm-house, and, after a series of representations to the Commissioners of Woods and Forests, more particularly to Sir William Molesworth and Sir Benjamin Hall, aided by an excellent photograph by Dr James Duncan, portraying the mode in which the palms sent their leaves for many feet through the roof, I at length succeeded in getting a sum of L.6000 voted by Parliament in 1855 for this purpose.

After some delay in regard to contracts, &c., the building was commenced in May 1856, and was completed in about two years.

The new palm-house is situated to the west of the old one, with which it communicates by the removal of one of the sides of the octagon, thus making the two to appear as one building, and facilitating much the transmission of the plants. The new house is substantially built of beautiful sandstone from a quarry at Bishopbriggs, near Glasgow, and the roof is formed of curvilinear iron rafters. The advantage of having much solid masonry is great, and was strongly advocated by the late Mr M'Nab, than whom none was more successful in palm cultivation. This mode of cultivation is preferable to the plan of using iron and glass almost entirely. The solid masonry prevents rapid cooling in this variable climate; it retains the heat better, and it gives a certain amount of shade, which is very important in the growth of palms, more especially of such as are social. Moreover, the effect is much more imposing. Too great sun-light in a palm-house appears to be prejudicial, and hence the western exposure of the front of the present palm-house has some advantages, by enabling us more easily to screen the plants from intense light.

The sandy nature of the soil required that the foundation should be laid on two feet of concrete. The laying of this was attended with some difficulty, owing to the vast quantity of water which poured in on all sides. Above the concrete there is placed six feet of underground solid mason-work. This is succeeded by solidly-built stone pillars 4 feet 4 inches in breadth, separated by arched windows, 8 feet 8 inches wide, and 22½ feet high. There are about 35 feet of iron-work above the stone building.

The building has the form of a parallelogram, its length on the west side, or the front from north to south, being 100 feet over the foundation, 96 feet 6 inches over the walls, and about 90 feet within the walls; its width from east to west, 57 feet, and its height 70 feet 6 inches. The total length from the west side of the new palm-house to the east side of the old one, is nearly 120 feet.

The sides of our new palm-house form an arcade 35 feet high all round, set upon a continuous base, having the outside face relieved by pilasters and entablature of the Tuscan order—the arches being filled in with glazed cast-iron frames. The roof, which is of cast-iron rafters and glazed sashes, forms a dome of two stages, each about 17½ feet high—the lower one rising from the top of the sides to half the height of the roof, where a base is formed for the upper one. The glass of the roof is sheet-glass, twenty-one ounces to the foot.

Galleries are provided at the base of each of the domes for convenience of access in case of repairs, and the accumulation of snow or ice. Inside there is a series of fourteen light cast-iron pillars placed at a distance of 12 feet from the side, forming a rest for the top of the lower dome, and for the base of the upper one. One gallery is projected from the sides by cast-iron brackets, at the height of 35 feet from the floor, to which the public have access by two cast-iron spiral staircases. Another gallery is formed at the base of the upper dome, 51 feet from the floor. A stone stage, 2 feet high, is formed round the sides, and another, at 4 feet distance inside, for the smaller palms, leaving the entire centre area for the larger ones. During the present session of Parliament, L.1000 have been voted for the removal of the wooden roof of the old palm-house, and the substitution of an iron one. This will complete the arrangements for the present.

The ventilation is effected by the lowest centre panes in each of the sashes of the side arches being made to open, and three large valves are placed at the top of the roof, which, being opened, produce a general upward current. When more air is required, it is obtained by opening certain of the upright compartments at the base of the upper dome. The heating is by hot water, supplied by four cast-iron flued saddle-boilers, on an improved principle, suggested by Mr M'Nab. These boilers are connected with 1316 feet of 5-inch bore cast-iron pipes. Two of the boilers are connected with pipes which pass round the whole house, one set of pipes going to the right and the other to the left. The other two boilers are connected with pipes which go to the centre of the building in the first instance, and then return by the outside, the pipes connected with each thus passing round half of the building. By this means, provision is made for increasing and diminishing the heat as may be required.

The building has cost L.6500. It was opened on 1st April 1858, and the palms were transferred to it and arranged by Mr M'Nab by the 30th April. This was a great feat, when we consider that the greater part of the palms had been re-tubbed; and some of the specimens, such as *Livistona chinensis* and *Sabal umbraculifera*, weighed, with the earth at the roots, from seven to eight tons. They have been all successfully placed, and the effect of the whole is such as to give one a good idea of tropical vegetation. The tubs used are large round ones, which are more convenient, and have a better effect to the eye than the square ones previously used. Some of the tubs are 22½ feet in circumference.*

The construction of the house enables one to see the palms in all directions, both from below and from above. On the outside of the upper dome there is a gallery where a fine view is obtained of Edinburgh and the country around it, extending from the Pentland Hills on the west, to North Berwick Law and the Isle of May on the east, and including also a view of Fife and Stirling shires, of the Ochils, and of some of the Highland hills.

The building does great credit to Mr Matheson of Her Majesty's Works, who planned it. The mason-work has been most substantially built by Messrs Beattie, and the iron-work is highly creditable to the Shotts' Company.

We are certainly much indebted to Sir Benjamin Hall, late Chief Commissioner of Works, for the deep interest which he took in the building, and for the strenuous support which he gave on all occasions. He visited the building several times during its construction, and at all times showed a desire to promote botanical instruction.

The following is a list of some of the palms which have flowered in the Botanic Garden:—

Caryota urens.
C. sobolifera.
Seaforthia elegans.
Euterpe montana.
Sabal umbraculifera.
Harina caryotoides.
Chamærops humilis.
——var. *arborescens.*
Chamærops Palmetto.
Chamædorea Schiediana.
C. Hartwegii.
C. coronata.
Rhapis flabelliformis.
Calamus Wightii.
Areca triandra.
Desmoncus elongatus.

The following are the heights of some of the present palms:—

	Feet.		Feet.
Livistona chinensis, .	43	*Plectocomia elongata*, .	38
Sagus Rumphii, . .	43	*Seaforthia elegans*, . .	26
Caryota urens, . .	42	*Corypha australis*, . .	23
Euterpe montana, . .	38	*Phœnix sylvestris*, . .	20
Acrocomia aculeata, .	37	*Elaïs guineënsis*, . .	22
Sabal umbraculifera, .	30	*Phœnix dactylifera*, . .	21

The above heights include the depth of the tubs.

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* Mr M'Nab states that, among the numerous adventures attending the removal of the palms to their new abode, one circumstance ought to be recorded, viz., the perilous task of cutting the top off the *Caryota urens*, which had to be done before it could be removed from the high lantern part of the roof of the old house. William Bell, one of the journeymen gardeners, volunteered the task, and accomplished it with safety. The glass was broken on the outside, and the top removed with a saw.

3. *Notice of an Excursion along the Line of the Roman Wall from Chollerford to Wall-Town Crags.* By Mr John Sadler.

4. *On the Occurrence of* Ledum palustre *near Bridge of Allan.* By Mr A. Buchan. Communicated by Dr George Lawson.

5. *List of Cryptogamic Plants collected near Moffat.* By Dr W. Nichol.

6. *Notice of Trees struck by Lightning.* By Mr James M'Nab.

Mr M'Nab read a letter from Mr Anderson, gardener at Oxenford Castle, in which he gave the particulars connected with two ash trees which had been struck with lightning in the farm of Fordel, one during 1853, and the other, not 100 yards distant from the first, on the 16th of June last (1858). The latter tree had a stem 7 feet 3 inches in circumference, and about 30 feet high. The electric fluid first struck the tree on the south side, immediately under the junction of three branches, where a large oval portion of the tree seemed entirely taken out. It then travelled in a slight curve, passing through the tree from one side to the other, the bark still remaining on the side on which it entered; while, on the opposite side, all the bark was torn off, varying from 1 to 2 feet broad. One of the main branches is still entire, although much shaken.

Mr M'Nab stated that he was still in quest of information regarding lightning-struck trees in Great Britain, in consequence of the generally received opinion, that neither the beech nor the birch have ever been noticed to be injured with lightning. For the last fifteen years he has communicated to the Botanical Society the names of various lightning-struck trees, but neither beech nor birch were among the number. He formerly stated to the Society that the inhabitants of America generally resorted to beech trees during a thunder storm, from the fact of their not being liable to be struck with lightning. This he found to be the case through large tracts of country, and it induced him to institute an inquiry in Britain, which up to this period agrees with the information he received in America.

7. *Remarks on the Applications of Photography to Botany.* By A. J. Macfarlan, Esq.

The application of photography to botany may conveniently be considered under three divisions,—1*st*, The delineation by the ordinary camera of trees, shrubs, &c., on a reduced scale; 2*d*, The photographic printing of ferns or leaves, the natural size; and, 3*d*, The micro-photographic process of obtaining magnified representations of the various tissues composing plants.

As we have, during the past winter, heard a good deal about the first division of this subject, I need not now say anything regarding it, further than to remark, that those who at the April meeting saw the photograph which illustrated Dr Balfour's paper on the *Narthex Assafœtida*, must have been convinced of the great use this department of photography may be to botany, especially when we call in the aid of the microscope; and were further proof required, Professor P. Smyth's views of the Great Dragon Tree of Orotava, &c., at once afford it.

As regards the photographic printing of ferns, although the results may not be so beautiful as those obtained by "nature printing," and although the process is a little tedious, yet it is so easily managed that it might more frequently be taken advantage of than it is, where accurate impressions of a frond are desired. The printing may be done in the same way as photographers are accustomed to obtain copies of negatives.

The application of micro-photography to botany much exceeds in interest either of the two to which reference has already been made, and, although as yet it has been but little practised, we may hope that it will not long continue so. Mr Bryson of this city has devised a very convenient form of apparatus, which I shall now describe. It consists of a camera which, being in one piece, cannot be lengthened or shortened, as is the case with the common one. At the one end, or front of the camera, instead of the ordinary lens, is fixed a brass tube for supporting the object-glass of a microscope, and at the upper end, as well as at the centre and half way between these two last points, may be inserted the ground focusing glass, or the frame which holds the sensitive plate. The stage, where the object to be taken is placed, slides upon a brass rod that projects from the front of the camera beneath the lens, thus constituting the coarse adjustment; while a fine focus is obtained as follows:—The object-glass, by means of an adapter, is screwed to a brass tube, which slides within a larger one, attached, as I have already mentioned, to the front of the camera. By a fine screw and an opposing spring the smaller tube may be more or less enclosed within the larger one, and consequently the object-glass brought nearer the stage, or removed further from it. The screw is connected by a metal rod, with a handle conveniently placed at the other end of the camera. Sometimes a microscope itself is attached to the camera, in which case, the stage and focusing apparatus are not required, but the saving in expense is not great. It is probably more than counterbalanced by the inconvenience of the arrangement. Those who are possessed of a microscope and one of the ordinery landscape or portrait cameras, may succeed in the process if they remove the lens from the camera and substitute for it the microscope deprived of its eye-piece; care, however, must be taken that a line passing longitudinally through the compound body of the microscope shall fall at right angles upon the ground glass, and also that all extraneous light be excluded from the camera. The photographs may be taken by the ordinary collodion process. The time of exposure of the sensitive plate in the camera varies from a second up to even five minutes if the day be dull. The light may be obtained by pointing the camera directly at the sun or a white cloud, or, more conveniently, indirectly from the sun by means of a mirror. The interposition of a piece of ground glass between the mirror and the camera diffuses the light over the field, and also renders it whiter and more agreeable.

8. *Recent Additions to the Edinburgh Flora.* By Professor Balfour.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Memoranda of the Effects of Carburetted Hydrogen Gas on a Collection of Exotic Plants.—During the prevalence of severe cold weather in the latter part of January, and first few days in February 1857, the earth was frozen to an unusual depth. Beneath the stone pavements in the streets of Philadelphia, the frost penetrated to a depth of more than three feet. In the neighbourhood of Arch and Eighteenth Streets, and along both those streets for the distance of nearly one hundred yards, the escape of gas from the main pipes under the street had been remarked for several weeks. Leaks at the joints had probably existed for months, although the porous nature of the soil had allowed the gas to diffuse itself, and find numerous vents at the surface. But the solid crust of frozen earth forced it to seek other channels of escape.

At this time, with the thermometer ranging from zero to 10° or 15° Fahrenheit, a current of gas, penetrating the imperfectly-secured joints of the main-pipes, made its way beneath the eastern foundation-wall of the greenhouse of B. A. Fahnestock, on the south-west corner of Arch and Eighteenth Streets.*

When entering the houses on the morning of the 1st of February, the odour of gas was perceptible, which, on examination, was found issuing in a tolerably strong current through the ground near the north-eastern corner of the greenhouse. It came up through a prepared border of soil between the wall of the house and the flagging of the greenhouse floor. Although somewhat relieved by ventilation during the day, it was impossible to prevent its accumulation through the night; and by the following morning the work of destruction was accomplished. A choice and beautiful collection, numbering over three thousand plants, was, for the time being, almost utterly ruined. Many of the specimen plants were unique, and but rarely found in American collections. The house, which a day or two before had given promise of an abundant succession of winter flowers, now presented the desolate appearance of tender vegetation after a severe frost. In some parts of the premises scarcely a single plant retained a leaf or bud. By the universal diffusion of this gas through the houses, many of the severest sufferers were those farthest removed from the point of its ingress.

That the plants had been absorbing carburetted hydrogen for some time was evident from the fact, hitherto unaccountable to the gardener and ourselves, that they had been occasionally shedding buds and leaves. Had there been no plants in the house, the peculiar odour of gas would doubtless have been perceptible for some days before the accident. Its volume proved to be much greater than we at first supposed. Those plants placed upon or near the floor, or upon the lower tiers of staging, suffered less than the taller specimens, or than such as were near the upper sash. This was especially the case with the camellias and other hard-wooded plants.

The *full extent* of the damage was not apparent at first. Many plants maintained their fresh greenness, without becoming shrivelled or withering; yet, although *seemingly* in fine health, they shed every leaf at the slightest touch. Syringing was resorted to, with the hope that the absorption of water might, in some degree, counteract, or neutralize the noxious effects of the gas; but in most instances, the leaves and buds fell off when treated with gentle streams of water from a finely-perforated syringe.

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* In order to convey as correct an idea as possible of the relative positions of the plants within the houses, it may be proper to observe briefly that the greenhouse is one hundred feet in length, by twenty-five in breadth, runs north and south, and is substantially constructed of brick, with a span roof of sash. The western side is also of glass from within four feet of the ground. The span commences about eight feet from the floor, with the apex about seventeen feet in height. Included within the same range is the hothouse, separated from the greenhouse by a sash partition, and communicating by two sash doors. At the extreme end, farthest from the leak, a small orchid-house opens into the hothouse.

As no plant suffered unless in leaf at the time, it seems evident that the injury was effected and sustained by absorption through the medium of the foliage alone. The volume of gas was too small to be absorbed to any extent by the earth or roots of the plants. Bulbs, and other plants, dry and at rest, were distributed in considerable number through the houses, both upon the upper shelves and beneath the staging.

A row of grape vines (not in leaf) stood against the eastern wall within the greenhouse, growing in a prepared border of earth under the table. The gaseous current passed directly through their roots. Saturated as the ground seemed to have been with fresh gas, which was strongly manifest on taking up a handful of the earth, they do not appear to have sustained any injury thereby. A row of maple trees, along the outer edge of the foot-walk on Eighteenth Street, were also directly in the way of the current. They were not more than eight feet from the leaking pipes. Owing to the depth of frost, it is probable that the flow of gas passed beneath their roots; nevertheless the ground within a few feet was black with the "*dead gas.*" They sustained no apparent injury, put forth their leaves in the spring, and grew through the season with their usual vigour.

As a general rule, the hard-wooded plants fared the worst. Succulents were the first to wither, and the first to recover. Large numbers of both hard and soft-wooded lost their tender twigs and young wood, which withered and required pruning as far back as the sound growth. While some showed signs of life, and began to put forth leaves within a few weeks, others lingered for months; some died after a sickly existence, and many were killed outright. Some plants near the leak, and under the full influence of the gas, manifested no apparent injury; others, in the remote orchid-house, were violently affected, exhibiting an astonishing sensibility. It seems rather anomalous, that of the Orchidaceæ, whose sustenance is derived mainly from the atmosphere, every individual should have exhibited a total indifference to the gaseous influence. Several large specimens of *Bletia Tankervillii*, as well as plants of *Cypripedium venustum* and *insigne* passed unscathed through the heat of the battle.

That plants in general are peculiarly sensitive to this gas, even when it is almost consumed by combustion, seems to be well established. The experience of florists who supply blooming plants at entertainments, is, that the plants having been thus exposed, are often in a sickly condition for some time thereafter. This is especially the case with camellias. They frequently shed their foliage, and have been known to die after an exposure of a few hours in rooms where many gas-lights were burning. This has no doubt been caused *in part* by the heated and impure air arising from crowded assemblages; but, if so, similar effects would be alike apparent in horticultural exhibitions when open only by daylight.

No experiment similar to the present has ever, to our knowledge, taken place upon so great a scale, or included within its range so large a number of genera. Solitary instances have been occasionally noted in which a limited number of species have been brought within the influence of acid and inflammable gases. Examples are not wanting, indeed, to confirm the destructive effects of carburetted hydrogen on vegetable organism. Many of the fine old elms in the streets of New Haven have been killed by leaks from the neighbouring main gas-pipes. Similar effects have been observed in Boston, Albany, and other cities in the United States.

In a review of a paper entitled "Ueber Gasfabrikation und Gasbeleuchtung vom sanitätspolizeilichen Standpunkte; von Dr Innhauser (Wien. Wochenbl. 35, 1856)," the author quotes the observation of M. Ulex, of Hamburg, as follows:—"In this city there are a great many linden and elm trees. In 1851, 159 of these trees had to be cut down because they had died. It was found that the bark immediately above the ground, often as far up as eight to ten feet, was quite loose, and completely separated from the wood; the roots soft and red, the fibres of the roots soft and rotten. The interior of the trees was perfectly sound. This injurious effect upon the trees is not only caused by the gas which escapes unburnt in the flame, but more particularly by that gas which leaks through the pipes in the ground. It was sometimes perceived at a distance of fifteen to twenty-five paces from the pipes. The same observations were made in Paris, Bourdeaux, Düsseldorf, Mannheim, Basle, and Vienna. Professor Bertulus of Marseilles thinks that the combinations of sulphur and ammonia in the gas saturated the ground with hydrosulphate of ammonia, which also causes the black colour of the soil."*

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* Although not strictly within the range of the subject at present under consideration, it may not be out of place to remark, that many instances are on record which show that vegetation has been seriously injured by *acid* gases from manufactories, especially in Belgium and Prussia. The same causes are said to have produced similar effects in a modified form in the vicinity of Philadelphia. This may account for the unusual mortality among the *Liriodendron tulipifera*, and other indigenous forest trees, killed from time to time in Penn Square, in the neighbourhood of the United States Mint.

In the Transactions of the Society for the Encouragement of Industry in Prussia (1857), is published an interesting extract from a report by Professor Dr E. L. Schubarth of Berlin to the Belgian government, "On the Acid Gases which Escape from the Manufactories, of Sulphuric Acid and of Soda, and the Means to Render them Innoxious." It seems that "numerous complaints of the farmers, that the vapours from the chemical manufactories in Belgium injured the vegetation of the fields and gardens, induced the government (of Belgium) to appoint a commission to examine this matter. This commission consisted of chemists, botanists, and farmers. During the summer of 1855, the excitement among the people, who even ascribed the potato-rot to the influence of the chemical factories, had so much increased, that several attacks were made upon the factories. The government therefore increased the number of the commissioners, and at the end of the year they made a report, which was published under the title "Fabriques de produits,—Rapport à M. le Ministre de l'Interieure par la Commission d'enquetre, Bruxelles, 1856." They say it was an admitted fact, that vegetation is injured by the acid gases from chemical works, but this influence is often overrated; the spots on the leaves, and injuries of the flowers, ascribed to acid gases, are very frequently the result of other causes, as frost, microscopic, vegetable, and animal parasites, deposits of foreign matter upon the leaves, very intense sunlight, &c. The potato-rot is certainly neither caused nor increased by these gases. On the other hand, chemical investigations proved the presence of traces of hydrochloric acid in spotted leaves and in the dew upon the plants. Similar spots could be artificially made by moistening the leaves with dilute hydrochloric acid, the presence of which could be proved after an interval of eight days. The report contains a list of trees injured by these gases.

* Several chemists of high reputation have made examinations of the gas of the Philadelphia Gas-Works, but from some cause their results are at variance. In order to facilitate the further researches of such as may desire to investigate

(See Schmidt's "Jahrbucher der gesammten Medicine," Band. 96, 1857, No. 11.)

In reviewing these simple facts, several questions naturally arise which possess more than ordinary interest for the vegetable physiologist, and may lead one step towards eliciting new developments in the chemical organization of plants.

Although no narrow nor definite limits can be drawn, still, the general characteristics tend to prove, that a sympathy does often exist between genera of the same natural order. In glancing over the effects of carburetted hydrogen gas upon each genus, this sympathy is frequently apparent throughout the various members of a family.*—(*Proceedings of the Academy of Natural Sciences of Philadelphia*, May 1858.)

ZOOLOGY.

Microscopic Examination of the Integument of Crustacea.—In order to arrive at more certain results in the identification of species, we think that microscopic examination of the surface of the integument will be found peculiarly useful. This mode of examination of species may be applied to a considerable extent throughout the crustacea generally with great advantage; and if found valuable in recent, there can be no doubt that it will prove of far greater importance in extinct forms, where facts on which the identification of species usually rests are lost, and fragments only of the animal obtainable. It should be borne in mind, however, that as the structure in question undergoes modifications more or less considerable in different parts of the animal, it will always be advisable to compare the corresponding parts with each other.

Applying this test to the known species of *Galathea*, we perceive that the structure of the integument upon the arms exhibits a squamiform appearance, but that the scales which characterise the structure possess features peculiar to each species. Thus in *G. strigosa*, the scales are convex, distant from each other, smooth at the edge, and fringed with long hairs. In *G. squamifera* they are convex, closely placed, scolloped at the edge, and without hairs. In *G. nexa* the scales are obsolete, tufts of hair representing the supposed edges."—(*Spence Bate. Proc. Linn. Soc. for August* 1858.)

"*Vanessa antiopa*" *in Scotland.*—There is no department of entomology

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its effects on vegetable organism, I insert the analysis of Dr C. M. Wetherill, made in 1852, for the engineer of the Philadelphia Gas-Works. This is probably as nearly correct as can at present be determined.

Per centage by volume, gases dry, at 0° *Cent. and* 1000 *Millimetres Barometer.*

	A.	B. 1	B. 2
Carbonic acid, ...	00·000	...	...
Olefiant gas and hydrocarbon vapours,	8·157	8·963	9·023
Oxygen, ...	0·052	0·136	0·120
Hydrogen, ...	...	44·168	...
Light carburetted hydrogen, .	...	41·620	...
Carbonic oxide, ...	...	5·081	...
Nitrogen, ...	...	0·059	...
		100·000	

(Journal of Franklin Institute, Philadelphia, July 1854, vol. xxviii., No. 1, 3d Series.)

more difficult to deal with than that of the distribution of insects. We cannot account for the occurrence at uncertain periods of great numbers of a species, at other times far from being abundant, or for the appearance of a few specimens of a species in a district where it was never before observed, and which is generally beyond its range of distribution. This is very remarkably exemplified in some of the Lepidoptera. *Gonepteryx rhamni* has never yet been known to occur in Scotland, though it is a very common English insect, and is not unfrequent in the Lake District only a few miles distant from the border. *Colias edusa*, again, has a very wide geographical range, but is a southern insect, and in Great Britain is confined almost to the south or south-eastern coasts, yet this species occurred last year (1857) on the coast of the Solway, near Southerness in Galloway, where probably a dozen or fifteen specimens may have been seen and taken, and this year it has again appeared at Colvend, upon the same coast, about ten or twelve miles west, where six specimens were taken by Mr W. G. Gibson of Dumfries. *Vanessa antiopa*, another butterfly of very uncertain appearance, even where most common, is also a southern insect, but stray specimens have occurred northward. Thus it has been taken near Durham. In Scotland, the late Mr James Wilson mentions one taken near Beith in Ayrshire; another was caught in presence of Mr Small, preserver of animals and birds in Edinburgh, on the banks of the Canal between Glasgow and Paisley; and we have now to record a third specimen, taken near Jardine Hall, Dumfriesshire, on 20th August last. This is the large variety, having the border surrounding the wings pale yellowish-white. It is in perfect condition, and could not have long escaped from its chrysalis.

GEOLOGY.

On some Additions to the Knowledge of the Cretaceous Rocks of India. By THOS. OLDHAM, LL.D., F.R.S., M.R.I.A., F.G.S., &c., Superintendent of the Geological Survey of India.—At the meeting of the Asiatic Society for the month of May 1857, Mr Henry Blanford and myself were present, with the intention of laying before the Society a brief notice of a very important discovery bearing on the geology of India which had not long previously been made. This was the fact of the occurrence of rocks of the cretaceous epoch in the western portion of the Nerbudda district. And the specimens illustrative of the intended communication were laid on the table. The attention of the meeting on that occasion having been fully occupied by other matters of interest and importance which came before it, time did not allow of this geological communication being brought forward, and as both Mr Blanford and myself shortly afterwards left Calcutta, the subject was not again brought before the Society. I am, however, desirous of recalling these facts, from the circumstance that the same discovery has subsequently been brought forward elsewhere, and I desire to place on record the facts of the case more fully than has hitherto been done, that the friend whose zeal first led to the discovery may be rewarded by obtaining full merit for his intelligent research.

All those who have given any attention to the study of Indian geology are aware, that previously to last year rocks of the cretaceous epoch were only known to occur in the south of the Indian Peninsula, forming a band, the limits of which were supposed to be near Trichinopoly on the south, and near Pondicherry on the north. The true relations of this band of cretaceous rocks have never been fully investigated, but a very beautifully preserved and numerous suite of fossils had been collected from them by Messrs Kay and Brooke Cunliffe, of the Madras Civil Service, which were presented to the Geological Society of London. The description of these fossils was undertaken by the late Professor Edward Forbes, and a most valuable and instructive memoir, fully illustrated with excellent plates, was published in the third part of the 7th vol. of the Geological Transactions, London.

After giving a detailed description of the species found, Professor Forbes entered on a discussion of the inferences to be drawn from the Fauna thus represented. It must be borne in mind, that previously to this publication, the occurrence of any rocks,—representatives of the cretaceous epoch in India,—had often been denied, and that there was no fixed geological horizon to which such a new discovery could be referred. The physical relations of the rocks containing the fossils to any other recognised groups were unknown, and it was only from a discussion of the organic remains contained in them that any just inference as to their geological age could be attained.

Professor Forbes entered fully into this discussion, and, from a careful analysis of all the evidence, arrived at the conclusion, that all the beds from which fossils had been obtained were parts or members of one and the same series, and that that series was equivalent to the cretaceous series of Europe; the deposits at Trichinopoly and Verdachellum being probably equivalent to the upper greensand and gault divisions of that series; the deposit near Pondicherry being equivalent to the Neocomien, or lower greensand.

During a brief visit to Madras in the autumn of 1856 I was indebted to the kindness of Mr Brooke Cunliffe, one of the original labourers at these deposits, for a valuable collection of these fossils chiefly from the Utatur locality. This collection at once proved the correctness of the closing words of Professor Forbes' valuable paper, that "Verdachellum and Trichinopoly will doubtless yield many more species than have yet been brought to Europe," for in it were many beautiful and well-marked forms previously undescribed. But it also showed conclusively, that a still further and more careful research was requisite before it could be supposed that anything like fair data had been obtained for arriving at trustworthy conclusions as to the true character of the Fauna of this period in Southern India. The relative abundance of species, and even of genera, seemed in many respects very different from that which the original collection gave, and it appeared *probable* that much of this difference in different localities was the result of a difference in depth of the sea at the time of deposit, and not of difference in time—a result not in accordance with the conclusions arrived at by Professor Forbes.

Among the small collection presented by Brooke Cunliffe, Esq., not less than 93 species were distinguished. Of this large number only 33 were known to Professor Forbes from the original collection; leaving an addition to the Fauna known up to that time from these rocks of 60 species. Without exception, these 60 species all tended to confirm the opinion of Forbes, that these rocks were of cretaceous age. A summary is given below of these additions generically, reserving the details of specific description until it is possible to prepare illustrations of the fossils. But a group or two may be referred to, in illustration of our remarks. Thus, taking the several well marked sections of the great genus *Ammonites*, among the large addition to the known catalogue of species which Mr Cunliffe's collection has given, we have none of the *Fimbriati*, an oolitic and cretaceous section; none of the *Flexuosi*, also a lower cretaceous section; none of the *Dentati*, also lower cretaceous; none of the *Armati*, an upper oolitic section; none of the *Lœvigati;* while on the other hand, of the *Cristati*, a section essentially cretaceous, we find one; of the *Clypeiformi*, also a cretaceous section, one; of the *Heterophylli* five, and *all* of the cretaceous subdivision of this section; of the *Ligati*, a group essentially cretaceous, not less than ten.

Of *Nautilus*, a genus having a larger development in the upper than in the lower beds of the cretaceous, we have three allied to other cretaceous forms; of *Belemnitella*, confined to the upper portion of the cretaceous group, one. And other instances might be given. These will, however, suffice to show, that a vast addition to the cretaceous Fauna of India still remains to be worked out.

I would add, that Mr H. F. Blanford, with others, is at present engaged in making out the relation of these rocks, and I confidently anticipate, that much light will be thrown upon the subject by the careful examination of the Officers of the Geological Survey in that district.

Abstract of Fossils from Utatur near Trichinopoly.

	Species previously known.	Species unknown.
Zoophyta.		
Turbinolia,		
Echinodermata.		
Brissus, .	3	2
Nucleolites,	0	1
Holaster,	0	1
Crustacea.		
Cancer (?)	0	1
Mollusca. (*Acephala.*)		
Inoceramus,	0	3
Pecten, .	2	0
Ostrea, .	0	4
Gryphœa,	2	1
Pinna, .	0	2
Arca, .	0	4
Pectunculus,	0	1
Modiola, .	1	1
Trigonia,	1	1
Solecurtus,	0	1
Cardium,	0	2
(*Gasteropoda.*)		
Natica, .	1	0
Trochus,	1	0
Pleurotomaria,	1	0
Voluta, .	2	0
Phasianella,	0	1
Strombus,	1	0
Tornatella,	1	0
(*Cephalopoda.*)		
Baculites,	2	0
Ptycoceras,	0	1
Hamites,	5	4
Turrilites,	1	1
Ammonites,		
Cristati,	0	1
Lœvigati,	1	0
Clypeiformi,	0	1
Heterophylli,	1	5
Ligati,	3	10
Nautilus,	1	3
Belemnites,	0	2
Belemnitella,	0	1
Annelida.		
Serpula, .	0	2
Pisces.		
Odontaspis,	1	0
Otodus, .	2	0
Lamna, .	0	1

The above list refers solely to the collection of fossils presented to the Geological Museum by Brooke Cunliffe, Esq.

Nerbudda District.—During the season of 1855–56, while engaged in the examination of the Valley of the Nerbudda, I had the pleasure of meeting Captain R. H. Keatinge, Assistant Political Agent for Mewar, at Poonassa. Among other things, our conversation turned upon the coralline limestone, of which the ancient town of Mandoo had been built. I took the opportunity of pointing out the extreme interest attaching to this limestone in a geological point of view, and the utter ignorance under which we rested as to its age or relations. It had been very ingeniously and correctly inferred by Dr Carter, in his carefully compiled "Summary of the Geology of India," that this limestone used at Mandoo had been derived from near Baug or Bagh, which inference I pointed out to Captain Keatinge in Dr Carter's paper, telling him at the same time my own impression, that it would prove to be not oolitic, as provisionally supposed by Dr Carter, but of the nummulitic age. I strongly urged Captain Keatinge to visit the locality indicated, and to collect any fossils that might be found, feeling confident that it would yield a rich harvest of many forms other than corals. I felt sure that it was only requisite to point out to this enlightened officer the interest of the inquiry to secure his zealous co-operation. Nor was I disappointed. In a letter, dated November 4th, 1856, after stating that he had been prevented from getting out much sooner, as he had intended, he says,—"I started west, without, however, the least idea of where I was going to. I got out twenty miles to Kala Bowli all well. I mounted at a quarter to one P.M. to go to Cheera Khan, which name sounded well. It was distant eight, ten, five, fourteen coss, as you pleased. Early in the afternoon I got it down to three coss, but alas I rode until after dark, and it was still three coss, and is three coss now, I believe, at least I never get any nearer. . . . I talked to the Bheels about black stone, until I succeeded in making them say that I should find white, which consoled me much. . . . . From the information I got I started the next morning in a south-west direction for Deola, on the Maan River. After going a coss I saw the limestone in the bed of a nullah, and in a coss more I was in the midst of it. Where I was (near Deola) the limestone lay in a valley about a mile broad. North and south the country was all hilly, the top of the hills covered with trap; and the bed of the Maan trap. I could make nothing of the general geological arrangement. In the valley the limestone was horizontal, on the hill sides it always seemed to slope down hill, but it may have been merely that the slabs had fallen one over the other. But the fact is, I had only two days to work in, and occupied them in collecting fossils.

"Higher up at Surbaperce on the Maan, I thought I traced the following succession (ascending):—A light green stone, metamorphic or volcanic; a soft sandstone, very fine grained, and white; compact limestone, bluish white; and then the coral limestone, the latter only containing corals. The compact fine limestone is found at intervals all over the jungle, and has been very largely used for lime in the Mandoo days; the old kilns are without number, Now as to the fossils, I found them wherever an edge of stone lay over a convenient mud-bed to retain them; and oh! the spear grass!! &c. &c. The *Echinida* (*Micraster coranguinum**) were in great plenty (the Bheels call them Paunchia, from their five marks), and what I suppose to be *Pecten 5-costatus*.† *Plagiostoma spinosum* and *Terebratula octoplicata* were numerous, the latter the most numerous and in best preservation. There are a good many other things, too, you will find in the box I have to day posted for

* This is a *Brissus*.

† It is so.

you. There are pieces of a large, finely marked *Echinus* (*Cidaris*), and I have a half one of the same sort, of which I send you a sketch. I have kept it to show the natives what I want on some future occasion. There is also a rude impression on a stone I have got, of a very large shell, say six inches long.*

"I have kept half the fossils to show Mr Blackwell, but you will find some nice small ones wrapped separately in paper."

On receipt of these fossils they were at once looked to, and it was found that although some of these specific distinctions were not correct, they entirely supported the conclusions of Captain Keatinge; and that here to the West of Mhow and Indore, in a country where such was before altogether unknown, there existed extensive beds of the cretaceous series. The importance of this fact, in its bearing on all reasonings as to the physical geography of the country at former periods, will be obvious to every one who has considered such questions, and its influence on the question of the still doubtful age of the rocks in the adjoining district was also great. Eagerly, therefore, I congratulated Captain Keatinge on his valuable discovery, and urged a further exploration of the field. And I had the pleasure of hearing the result in the beginning of the year (March 1857). Captain Keatinge had, in company with Mr Blackwell, Mineral Viewer to the Bombay government, revisited the Baug district in the month of January, and has favoured me with an extract from his journal, which being brief, and full of interest, I give entire.

Extracts from Captain Keatinge's Journal.—14*th January* 1857. —From Mundlaisir marched fifteen miles to Khul, where the Bombay and Agra road crosses the Nerbudda.

15*th.*—Passed by Dhurmpooree, and on to Tolie, a small village in the jungle.

16*th.*—Munawer, a town on the River Maan; west of the town is a small temple in a field, some of the pieces of limestone of which it is composed are a mass of shells.

17*th.*—To Dherree, a large village on the Ourie river. All about Dherree the country is composed of a breccia of trap, with some limestone and sandstone pieces amongst it, some of them are a little rolled, but the most are angular. From Mundlaisir to Dherree all the country is of trap, with no jungle, except a small babool scrub, and uninteresting.

18*th.*—To Baug, the breccia continuing most of the way. Some three or four miles from Baug, sandstone is seen in the bed of a nullah, but the high land about is all trap. About two miles out of Baug the sandstone commences; it is of a light pink colour, easily broken up, and the plain is covered with silicious sand from it; in the bed of the stream we found pieces of black shale, which, on exposure to strong heat, bubble up into a slag, and on being left in a wood fire for some hours, turn light grey; we could trace no vegetable impressions in them.

19*th.*—To see the iron ore first proceeded east of the town some four miles, and came to the last works which were carried on some sixteen or twenty years ago. The ore lies in the body of a small hill, and has been most extensively quarried; it is a light yellow ore, like that of Nandia, near Burwah, and of Nancoot, but in far greater masses than any I have seen at those places, and has been most extensively worked. The deepest mine we went into measured 48 feet from top to bottom, and was about double that width. Quite close to the ore is a large hill of limestone, but so hard and deep blue that I was certain it was a trap, or metamorphic stone; on burning, however, it turned out a beautiful lime. Near the town are numbers of small pits and burrows, but no large mines like those to the east.

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* *Inoceramus?*

20th.—In the morning went to see the caves, the figures in them very fine and imposing, as seen by torch-light, and the situation very lovely; the Baugun river seems to have no single fall, but a continued rapid descent; the cliff in which the caves are situated consists of a mass of sandstones of all colours, sloping up to the north-east at a slight angle, and topped with a very hard and white friable limestone, in which we found some shell impressions. About five miles from Baug, to the east of the Noonsee Road, is a quarry of white sandstone, an even-bedded and soft stone, which is still carried a long distance for building purposes. It seems to be near the bottom of the mass of sandstone. In the evening rode out towards Cheeklee and Rajpoor, some five or six miles.

21st.—This morning to the village of Auggur, north-east of Baug, where iron has been very largely worked. Ore in great abundance; also the hard grey limestone. All about Baug, east and west, is a bed of shales, which seem to be nearly vertical, dipping to the south or south-west at a very steep angle. The ore seems generally to be in them.

22d.—Rode out along the road to Cheeklee, west of Baug, to the village of Mogra, about ten miles distant. At about six miles, found trap covering sandstone, up to that the country having shown nearly alternately sandstones and limestones. In the afternoon, leaving Mogra, we went nearly north to the village of Kharrwa, and from that east to Baug, seeing limestones and sandstones all the way, except one hill capped with trap.

23d.—Left Baug by the same road as entered it from Dherree, but struck off to the north-east from the second village; soon got into the trap again, with sandstones under it. About half-way to Bulwarrie, in the Ourie Nulla, near the village of Khojakoa, found a considerable thickness of sandstones, dipping to the north, and thickly covered with trap. Near Bulwarrie saw some curious metamorphic rocks, looking rather like granite; at Bulwarrie itself all seemed trap.

24th.—Marched to Kutchkonda. Up to half-way all seemed trap, but after that we got into the coral limestones, and continued through them to Kutchkonda. A good deal of stone has been quarried in a superficial way at this place, both to the north and east; the quarried stone lies just under trap. In the evening rode east some four miles, to see a fall in the River Maan; the fall is near the village of Neemkhera, and is caused by a barrier of trap; the height from eighteen to twenty feet, according to the place it is taken from. A considerable quantity of water was going over it in four streams. Between the fall and Kutchkonda, the river exposes a considerable thickness of crystalline limestones and shales in thin beds, dipping considerably to the north-east, and at Kutchkonda is a gritty shale, used by the barbers of all Nimar as a honestone.

25th,—*Viâ* Cheerakhan (meaning "cut-stone quarry") to Deora. The former is evidently the place from whence cut-stone went to Mandoo, and is so remembered traditionally. There are two small mosques in the

Mandoo style, built by the workmen of the olden days. The quarries lie on the tops of low hills, and have been quarried along the tops in a layer of about four or five feet, nowhere apparently deeper. The rock is here not covered with trap. The amount of stone that has been quarried is very large. From Cheerokhan to Deora the country is all limestone. A mile or two out of Deora, passed what appeared to be a fossil trunk of a tree lying on the road; and about half a mile east, a bed of thin shales dipping to the north. The thick limestone seems nearly horizontal. At Deora found that the people had collected a good many fossils.

26th.—In the morning, for several hours, fossil hunting; found some new ones, and saw a bank that appeared to contain more, and in which many were found in the evening. The fossil bed is composed of a clay, usually yellow, with some red and white veins in it, and with about a foot of compact limestone over it. The bed is intersected by a stream, and shows best near the village of Odeypoor: near it is also a bed of very friable limestone, looking exactly like that over the caves at Baug, but containing Echini and some small shells.

27th.—In the morning marched east, some six miles to the village of Putlowed, a deserted site on high ground near a small stream. The bed of the stream was all trap, but a number of Echini were distributed in the gravel of its bed, showing that it must pass through a fossil deposit. From thence to Buccaneer, south six miles, and so into Mundlaiser."

From these details it will be evident, that to Captain Keatinge alone is due the merit of having first distinguished these fossils as cretaceous, and to him also belongs the merit of having most zealously, and under considerable difficulties, collected a very tolerable series of them.

I have taken this opportunity of recording the facts above given, more especially because, in the last number of the Journal of the Bombay Branch of the Royal Asiatic Society, there is a notice regarding some fossils from the same locality in which the discovery of these most interesting fossils, and their identification as cretaceous, is not fully assigned to Captain Keatinge. And I desire to reclaim for that most active and enlightened officer the fullest award of credit which his exertions deserve. I do this the more anxiously also, because unexpected circumstances had prevented our doing so at the earliest opportunity, as intended, so long since as May last, the last of the fossils having only reached me a few days previously.

I shall not here discuss the conclusions arrived at by Dr Carter in the notice referred to,* that these beds are truly Neocomien, because I think we have not any sufficient data to reason upon. I feel confident that the hasty reference of any group of rocks, to some acknowledged European *subdivision*, based upon the occurrence of three or four ill-preserved and ill-identified fossils, is both unphilosophical and injurious. The evidence here is abundantly good to say that these rocks represent the cretaceous era, but altogether insufficient to enable one to refer them to any subdivision of that great series.

Reserving, as before, the detailed specific description of these fossils, a generic summary is here given of the number, &c.:—

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* Journal of Bombay Asiatic Society, No. XX., July 1857, page 621.

Summary of Fossils collected at Baug by Captain Keatinge.

	Species.
Corallines,	4 or 5
Echinodermata—	
Cidaris,	1
Echinus (species)	1
Brissus,	2 or 3
Cyphosoma,	2
Mollusca—	
Acephala Pholadomya,	1
Venus,	1
Cardium,	4
„ *altum. Sow; hillanum,* or very closely allied, and two others.	
Arca,	1
Modiola,	1
Mytilus,	1

	Species.
Mytilus typicus (Forbes)	
Pecten (Janina)	3
P. (*5-costatus*, common)—	
Plicatula,	1
Inoceramus,	1
Terebratula,	1
Gasteropoda—	
Rhynconella,	1
Natica,	1
Turritella,	1
Cerithium,	1
Triton,	1
Voluta,	2
Cephalopoda—	
Ammonites of the *Rhotomagensis* section,	2

I had hoped to have procured during the past summer an extended series of fossils from this locality, with a view of having it thoroughly examined. Mr William Theobald, junior, was deputed to remain in that district, after his field-work of last season had been concluded in the Nerbudda Valley. But the very disturbed state of all the country in that neighbourhood has rendered it impossible to carry out these views. Mr Theobald, after considerable risk, has escaped unhurt, but the examination of the Bagh country must be deferred to a more favourable opportunity.

I would merely add, that a brief notice of the discovery of the fossils was communicated to the Madras Literary Society, on February 12, 1857, and published in their Journal, No. 2, New Series; and also, that I took the opportunity of a brief communication on some points of Indian geology, made to the British Association for the Advancement of Science, at their meeting in Dublin during the past year, to place on record the claims of Captain Keatinge as the first who had made out these fossils.*

BIBLIOGRAPHY.

Monographie des Picidés.—Mon. Alfred Malherbe, so well known to ornithologists by the attention he has devoted to the family of the *Picidæ* or *Woodpeckers*, proposes now to publish, as the sum of his labours, a monograph of the woodpeckers and their allies—"*Monographie des Picidés* (Pics, Picumnes, Torcols, ainsi que les genres modernes compris sous les anciennes dénominations) ou l'Histoire Naturelle Générale et Particulière de ces oiseaux zygodactyles." The work will be completed in twenty-five livraisons folio, each containing five plates, with text. It will form two parts or volumes. The first will comprehend the general history of the group—viz., manners and habits, physiology, anatomy, changes of plumage, geographical distribution, &c., and will be illustrated by wood-cuts. The second part will contain figures and detailed description of all the species, with their synonyms and other references.

MISCELLANEOUS.

Meteorological Society of Scotland.—This important society will now be constituted. At a general meeting held lately in Edinburgh, the recent negotiations with government were explained to its subscribers and others interested in its success; and although support by means of a grant of money had not been obtained, the value of the society is recognised, and the reduction of the observations, and some other details, will be placed under the charge of Professor Piazzi Smyth, the Astronomer-Royal for Scotland, who has suggested the following arrangements with the Society, to enable him to carry out the important duties about to be assigned to him by Her Majesty's Government. In other respects the Society will continue quite independent; and when thus relieved of the expense of furnishing returns to the Registrar-General, will be enabled to devote more of its time and funds in pursuing the higher objects of meteorological science. The extent to which these may be carried out will depend on the general support received. The Society's observations will be published annually for the use of members, and will also be sold to the public.

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* A general sketch of the districts already visited by the Geological Survey of India was republished in the Edinburgh New Philosophical Journal, No. XII., New Series, page 320.

Professor P. Smyth's proposed arrangements.—"*1st*, The Society will carry on meteorological observations, as heretofore, at its own stations, and through its own observers. *2d.* These observations will be registered on schedules issued by the Society's secretary, each schedule containing a month's observations. *3d.* The schedules, immediately on the expiration of the month, will be transmitted by post to the Society's secretary in Edinburgh, by whom they are to be handed over to the Astronomer-Royal. Those from the towns of Greenock, Glasgow, Perth, Edinburgh, Dundee, and Aberdeen are to be delivered to the Astronomer-Royal, as nearly as possible, within three days, and from other stations, as nearly as possible within seven days after the expiry of each month. *4th.* The observations, so soon as received by the Astronomer-Royal, are, under his directions, and at the expense of Government, to be classified according to districts, and be reduced and corrected, in order that an abstract may be prepared, also under his directions, for the Registrar-General, and be transmitted to him at the proper time. *5th.* The Registrar-General will publish the abstract of the observations so prepared for him with his monthly and quarterly returns of births, marriages, deaths, and diseases. *6th.* The monthly schedules of observations, with the reductions and corrections made thereon, are to be carefully preserved at the Observatory, with the privilege to any of the Society's office-bearers of consulting them there, and of borrowing them for a period not exceeding a month at a time, on the written order of the Society's secretary, who will be responsible for their safety till returned to the Observatory. *7th.* The Astronomer-Royal, in the event of his discovering or believing that the observations in the schedules from any of the Society's stations have not been truly made, or have not been faithfully recorded, will have the privilege of communicating on the subject with the Society's secretary, stating at the same time the grounds of his belief; and in the event of nothing being done either to apply a remedy, or to satisfy the Astronomer-Royal of the trustworthiness of the observations, it shall be competent to the Astronomer-Royal, after two months' previous notice of his intention, given to the secretary of the Society, to omit from his computations for the Registrar-General the observations made at that station."

Some Experiments on Sonorous Flames, with Remarks on the Primary Source of their Vibration. By Professor WILLIAM B. ROGERS.—

The production of a musical sound by a small flame of hydrogen gas burning within a tube has long been one of the most familiar of lecture-room experiments. Professor Faraday, early in his marvellous career of discovery, showed that this musical vibration was not confined to hydrogen, but could be produced with flames of carbonic oxide, olefiant and common illuminating gas, as well as several other gases and vapours; and he was the first to give a philosophical theory of the sound, by rendering it probable that, in the conditions of the experiment, the flame resolved itself into a series of little explosions, which, succeeding each other at very small and equal intervals, gave rise to regular and therefore musical vibrations in the tube. This theory, afterwards confirmed by an experiment of Professor Wheatstone, in which, with his well-known revolving mirror, he rendered visible the intermitting combustion of the singing flame, has lately received a further illustration from Professor Tyndal's ingenious arrangement for observing the successive images of the flame as reflected upon a screen.

The recent beautiful experiments of Count Schaffgotsch and Professor Tyndal, proving that in certain conditions the flame is strongly impressible by external sounds, have given a new and unexpected interest to the subject, as is well shown in the curious observations of Professor Leconte in the January number of the " American Journal of Science ;" and I need hardly add, that they have also prompted the experiments and reflections embodied in the present paper. In presenting these, I shall follow the order in which the experiments were made, and from time to time communicated to the Boston Natural History Society and the American Academy during the past winter.*

1. *Production of Musical Sounds by Flames escaping from Wicks or Wire-Gauze.*—Early in these experiments I found that the usual absence of the sonorous effect in the case of lamps or candles burned under the same conditions as the gas, is not due, as might be supposed, to a mechanical interference of the wick with the vibrating motion. Wicks of cotton thread and of asbestus introduced into a jet-pipe of coal-gas one-tenth of an inch in diameter, do not prevent the singing even when they project far into the flame, and unless spread out raggedly at the sides, do not greatly impair the purity of the tone. Indeed, the difficulty of obtaining continuous musical sounds from a common flame with a wick would seem to be due rather to the nature of the combustible matter, which, requiring a very large supply of air to produce the explosions, and evolving too little heat in combustion, is liable to be extinguished before the musical sound is developed.

By using a small alcohol lamp, with a wick-tube about five inches high and one-fifth of an inch in diameter, I have succeeded in obtaining a very pure musical tone, when the blue and low flame was introduced into a resonant tube five or six feet long. The effect occurs only at a particular stage of the flame, and depends on so nice an adjustment between this and the tube as to make its repetition difficult and uncertain. With sulphuric ether the same arrangement is more frequently successful, but even this furnishes only capricious results.

To obtain an ether flame which will readily assume the sonorous state,

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* My earlier experiments and the general theory of the vibration, as explained towards the close of this article, were presented at a meeting of the Warren Club late in December.

I use a lamp consisting of a glass tube about eight inches long and one-fourth inch in diameter, open below, and drawn somewhat bluntly to a small aperture at top. Into this some loose cotton twine or thread of asbestus is introduced so as to terminate at or very near the pointed opening. The tube is then half filled with sulphuric ether, the larger end closed with a tight cork, and the little ether lamp fixed upright in the centre of a wooden block. On applying a light to the apex, the ethereal vapour burns in a steady jet, which, with proper tubes, enables us readily to repeat most of the experiments on the singing flame. This simple apparatus acts freely at ordinary temperatures, and may be used from time to time for several days without replenishing.

Finding that the ordinary solid wick gave such unsatisfactory results, even with an ether flame, it occurred to me that a hollow wick, by its larger exposure to the air, would be more favourable to the formation of the explosive mixture, and therefore to the production of the sound. This, on trial, proved to be the fact. By using *hollow wicks*, and resonant tubes but slightly exceeding them in diameter, I was able to obtain the musical effect with the flames of sulphuric ether, common alcohol, and the mixture of the latter with spirits of turpentine, which is known in this country as burning fluid; and by employing an iron tube at a high temperature with such a hollow wick, I have obtained, though less perfectly, a musical note from the flame of spermaceti oil.

These results may be readily obtained with the flame of the small circular wick-lamp now in use for burning the mixture of alcohol and turpentine. In this form of lamp, the wick-tube rises about two-and-a-half inches above the reservoir, and an external moveable tube is provided, which, being raised or lowered, serves to vary the depth of the wick on the outside, and to adjust the flame with great nicety. This appendage is important also as a means of giving the exterior of the wick a smooth outline, and securing an even action of the converging streams of air on the flame. The body of the lamp should be removed from its pedestal, and placed on a ring-support to secure a free current of air upward through the central wick-tube.

As the effect in these experiments depends upon the access to the flame of a current of air of definite amount and velocity, and in a proper direction, it is necessary to adjust the height of the flame and its position within the resonant tube to the dimensions of the latter. With a tube two feet long, the flame should be short, and placed so that its base may be about on a level with the lower edge of the tube. With one five or six feet in length, we must use a higher flame, and depress the tube an inch or more below its base. When this is done, the flame will be seen to contract and lose much of its brilliancy, at the same time giving forth a musical tone, which, with a little care in holding the tube, may be kept quite smooth and continuous. As a more precise guide to those who may wish to repeat this experiment, it is proper to mention, that the lamp above referred to has a sliding tube of about nine-tenths of an inch in diameter and an inner tube of nearly five-tenths, and that the resonant tubes best adapted to it are from twelve to fifteen-tenths of an inch in diameter, and from eighteen inches to six feet long. With these arrangements, an *alcohol wick-flame affords a clear musical sound with as much certainty and ease as an Argand gas-flame.*

Those who are familiar with such experiments are aware that, by the ordinary procedure, a bulky flame of illuminating gas cannot be made to assume the sonorous state. Yet, as might be expected, when such a jet is mingled with a sufficient proportion of common air, it does not fail, with a suitable resonant tube, to yield a powerful musical tone. To bring about this result, the air may be applied as a current to the surface of the flame, or it may be mixed with the gas below the place at which the combustion begins. As the effects of the former process will be shown under a subsequent head, I will confine myself to an exemplification of the latter as presented in the sonorous character of the large flame of mixed air and coal-gas formed on top of a wire-gauze burner when properly adjusted. In the ordinary arrangement of such burners, the proportion of air which becomes mingled with the gas before passing through the meshes of the gauze to form the flame, is quite insufficient to bring it to the state of an explosive mixture. By perforating the sides of the chamber beneath the gauze with numerous openings, and allowing also a wide entrance for the air below, we provide an efficient means for admitting a large volume of air, and for thoroughly mingling it with the gas.

The effect of such an arrangement is strikingly seen in the powerful sonorous vibrations first noticed by Mr W. F. Shaw of this city while experimenting with the *wire-gauze burners* which he uses in his gas-stoves. On inverting one of these burners over the jet so as to bring the perforated cylinder below, and the continuous metal tube above, the diaphram of gauze, he found that the flame, when duly adjusted, gave rise to a very loud continuous musical sound, which could be changed in pitch and strength by the addition of other pipes above. With a large volume of flame, the tone, as I have repeatedly experienced, becomes painfully intense, as indeed it should be, considering the energy of each of the successive explosions by which it is maintained. It may perhaps be supposed that the powerful current drawn upward into the tube by the heating action of so large a flame would, by its direct mechanical agency, contribute largely to the production of the sound. This, however, is shown not to be the case, by the necessity of a special adjustment of the supply of gas, and the cessation of the sound when the quantity is much increased.

2. *The Sonorous State may be Induced by giving a Rapid Motion to the Flame.*—When a jet of burning coal-gas is introduced into the resonant tube in a position in which it does not sing spontaneously, we may cause it to commence its musical performance by simply *vibrating the jet pipe rapidly from side to side.* In this experiment, the pipe should be covered with soft buckskin for two or three inches near its upper end, to prevent the sharp jarring sound caused by its striking the glass. This movement of the jet is so efficient in bringing on the sonorous state, that it will compel the flame to sing even in a tube in which it would not do so spontaneously in any position in which we could place it. Indeed, it will often excite the musical vibrations in cases where, from the unsuitable proportions between the tube and flame, the external sounds used in Schaffgotsch's and Tyndal's experiments entirely fail to bring on the sonorous state.

An arrangement which I have found well suited for this experiment consists of a jet-pipe, about ten inches long, with an aperture above of $\frac{1}{60}$th of an inch in diameter. It is attached to the metal gas-stand beneath by a piece of rather stiff vulcanized tube, of which about one inch of the middle portion is free to vibrate. The motion is given by applying the fingers to the upper part of the elastic tube, and may easily be varied in speed and restricted in distance as we desire.

Although the singing is induced more promptly when we allow the jet-pipe in its vibrations to strike the sides of the tube, this action is not at all necessary to the effect, for we obtain the same result when the pipe is merely shaken to and fro within such limits as to prevent its touching the glass. The effect here described is so striking and beautiful, that when first observed it cannot fail to excite surprise, especially if, from previous trials, we have found that the flame refuses either to sing spontaneously or under the action of external sounds.

So far as the impulse of the jet-pipe against the sides of the tube is influential in exciting the sound, we must ascribe its action to the feeble musical resonance produced by it within the tube, which, although composed of several sounds, may always be observed to include the fundamental note of the tube. This action is therefore like that of a unison note sounded by the voice or an external instrument, or that of any other mechanical agency giving rise to a vibration of the included column of air. But the other and far more remarkable effect, the excitement of the musical condition in the flame by simply moving it to and fro without striking the tube, cannot be thus explained, since the gentle impulses given to the air by the vibrating pipe produce no audible effect, and would seem quite inadequate to excite in the column any but the very feeblest vibration. Admitting, however, that these extremely faint vibrations of the air may contribute somewhat to the result, it can hardly be doubted that the main influence by which the movement of the jet produces the effect in question is by causing so rapid a mixture of the adjoining air with the gas, that the latter, before being inflamed, is brought into a condition to produce those small explosions which, by their quick succession, give origin to the sound. The effect of motion in bringing about this explosive condition of the flame is well exemplified by the following experiment:—

Fastening a jet-pipe, some twelve inches in length, into the end of the long flexible tube through which the gas is supplied, and holding it erect by a point a little below the insertion, so that we can readily cause it to vibrate, we ignite the gas, and adjust it to form a slender flame about an inch long. If now the flame be moved from side to side through a distance of five or six inches at a moderately rapid rate, it will assume, according to a well-known visual law, the appearance of a continuous arch of whitish light, retaining at the extremities the whole height of the stationary flame, but growing narrower from either side towards the middle. In these conditions the flame is *entirely noiseless.* As we gradually increase the speed of the vibrations, the arch, at a certain velocity, suddenly breaks in the middle, where a faint bluish flame takes the place of the usual whitish light, and at the same instant a *sharp noise is heard,* due to the inflammation of the explosive mixture at this part of the vibration. It is hardly necessary to say that, as the vibration is quickest at the midway point, coming to a pause at each end of the arch, the gas becomes more largely mixed with air at the middle than towards the extremities of the motion, and is therefore at this point earliest reduced to the state of an explosive mixture.

As we increase the velocity of the vibrations, the sonorous part of the arch extends towards the ends until the path of the flame presents the aspect of a narrow bluish band irregularly serrated at top, and flanked at the extremities by a tall flame of the usual whitish colour. As might be expected, when the jet is revolved rapidly in a circle, the white light entirely disappears, and the ring of bluish flame which results gives forth a continuous but not distinctly musical sound. When made in a dark room, these simple experiments were found to be unexpectedly interesting and beautiful.

The sound familiarly observed when a flame of any kind is blown upon, and especially when the air is forced into and through the flame, as in the case of the jet of a blow-pipe, was long ago referred by Faraday to the combustion of an explosive mixture formed by the air and burning matter. The sound produced by a blazing fire of wood or bituminous coal, contrasted with the silence of a flameless mass of ignited anthracite, is an obvious illustration of the same principle. But the experiments above described show the operation of this law under conditions which enable us more satisfactorily to mark the origin of the sound, and the gradations by which it accompanies the formation of the explosive mixture.

3. *The sonorous state may be induced by causing an additional supply of air to pass up the resonant tube.*—As in the above cases, the action was mainly traceable to the more rapid mingling of the atmospheric air with the flame, it was natural to conclude that a like effect would be produced by passing a current of air upward through the tube; and on trial this anticipation was strikingly verified. In order that the current may be evenly distributed, it is convenient to employ an argand burner, having the supply pipe at the side, and the central opening entirely free, so that the jet-pipe may rise through the centre, and the burner be adjusted to the proper distance below the flame and the bottom of the glass tube. The air conveyed to the argand burner through a flexible pipe may be supplied either from the lungs of the operator, or from an adjacent gasometer. In most cases the action of the current is more easily managed when the apertures from which it flows are some two or three inches below the bottom of the resonant glass tube.

With this arrangement, and a proper graduation of the current of air impelled into the tube, we can cause the flame to sing when the other methods above described have failed to produce any effect. When the flame is not far from the position in which it would spontaneously sing, the *lightest breathing through the argand pipe is sufficient to bring it to the sounding state*, and to maintain a clear smooth tone. Even when the flame is large, and otherwise not readily susceptible of the sonorous action, a stronger current of air applied nearer to the bottom of the resonant tube will rarely fail to bring on the musical vibrations.

In adjusting the argand jet-pipe to the most suitable position for this effect, we should be guided by the other conditions of the experiment. When the resonant tube is of moderate size, for example, three-fourths of an inch or an inch in diameter, and the flame not greatly larger than is suited to spontaneous singing; in other words, when only a small additional supply of air is required for the effect, the current will be found more manageable if made to ascend from a distance of two or three inches below the mouth of the tube. Using a much larger flame in the same tube, we must of course apply a stronger current to supply the requisite amount of air, and must therefore bring the air-jet close to the opening of the tube at the same time that we augment the force of the blast. With a tube of glass five feet long and two and a half inches in diameter, and a gas flame two inches high, proceeding from an aperture of $\frac{1}{80}$th of an inch, I find it best to bring the argand jet a little within the tube. Then by a gradually increasing blast I soon bring the flame to the sonorous state, and obtain a deep and powerful organ-tone.

In most cases the effect above described can be produced in a simpler but less satisfactory manner by using, instead of the argand burner to conduct the current of air, a common glass tube bent suitably, and held near the jet-pipe below or just within the opening of the resonant tube.

To show that the mechanical action of the air upon the lower edge of the inner surface of the tube has no direct effect in producing the musical tone, it is only necessary to repeat the experiment after extinguishing the flame, when it will be seen that the current of air alone gives rise to no decided sound.

The effect of a due admixture of air in bringing on the sonorous state, is still more strikingly exhibited when we use a concentric jet-pipe, in which the current of air is blown through a central aperture in the midst of an annular stream of gas. With such an arrangement, and a proper force of blast from the lungs or a gasometer, we may reduce a silent flame two or three inches in height to a short blue sonorous jet, which, with a suitable enclosing tube, will give rise to a sound of great volume and intensity. Using the larger tube (five feet by two and a half inches) before mentioned, I find it easy in this way to produce a tone of almost deafening loudness, or one of great smoothness and purity, by increasing or lessening the supply of gas and of air.

The preceding observations agree with those of other experimenters in favouring the conclusion that *flames of every kind are capable of exciting sonorous vibrations*, provided the air and combustible gases or vapours are brought together in such proportions as to form an explosive mixture; and they therefore confirm the explanation of Faraday, which refers the musical sounds produced in such cases to a rapid and uniform succession of small explosions.

4. *The intermissions of the singing flame are made visible by giving it a rapid vibrating or revolving motion.*—The intermitting character of the combustion in a singing flame has been beautifully shown by Professor Tyndal, by causing the light of the flame to fall upon a revolving mirror, from which it is reflected, so as to form a series of images on a distant screen. A similar resolution of the flame into successive explosions is more simply exhibited by moving it rapidly to and fro, or better still, by giving it a steady revolving motion within the tube. In using the former method, the jet-pipe attached to the common gas-stand by a short piece of flexible hose, may be passed through a ring so placed as to restrict the vibrations to a range less than the diameter of the tube. A sufficiently regular movement may then be given by the hand. If now we adjust the flame in the tube, so that it will not begin to sing for some time after the vibration has commenced, or until the tube is farther

lowered, we observe at first merely the continuous band of light due to the permanence of the visual impression, but as soon as the singing commences, this band becomes waved or serrated at top, and, with a proper velocity, divides into nearly separate columns of flame with obscure spaces between.

The effect is however far more striking when *the flame is made to revolve at a uniform rate in the tube.* In this case so long as it remains silent it presents the appearance of a hollow cylinder or short tube of whitish light, but the moment that the singing begins, the cylinder assumes a toothed form on the top resembling a brilliant crown, and *divides itself into a number of narrow luminous columns separated by bands nearly or quite deprived of light.* As might be expected, the number of these subdivisions, with a given rate of rotation, is greater in a short tube than in a long one, and is greater when the tube is yielding one of its harmonic notes than when giving its fundamental sound. In the same tube the number of subdivisions diminishes as we increase the velocity of rotation, a less number of vibrations or explosions in this case corresponding to one revolution of the jet.

To render the effect visible at a distance it is of course necessary to use a large tube and flame. It is, however, beautifully distinct when the tube is some six feet long by one and a half inches in diameter, and the flame three-fourths of an inch in height. The mechanism employed to give rotation to the jet consists of a grooved wheel connected by a band with a small pulley. Into the latter the supply-pipe enters from below by a smooth gas-tight joint, which allows the pulley freely to revolve. The jet-pipe secured to the middle of the upper face of the pulley tapers to the extremity, and rising to the height of six or eight inches, is elbowed near the top so as to give the flame when revolving an orbit of about an inch in diameter. To secure the pipe more firmly in its upright position, it is made to pass near its base through a narrow gallows of brass, in which it turns freely. This has two little cushions of buckskin glued on the top, for the convenience of supporting the larger tubes during the experiment.

In making this experiment it will be remarked, that although in the first instance the rotation of the flame often serves to excite the vibration, an increase of velocity weakens the force of the sound, and a very high speed actually annuls it, the flame at the same time resuming its normal appearance of continuity. This effect is not due, as might be supposed, to the air carried round by the revolving motion obstructing the full supply of oxygen to the flame, for I have found that it is not perceptibly increased by attaching a disc of card to the revolving arm of the jet-pipe; and, moreover, I have observed that a small singing flame, after being silenced by very rapid rotation, shows throughout its circuit the blue column due to a full admixture of air. More probably the cause of this weakening and destruction of the sound should be sought for in the mechanical interference of the successive pulses due to explosions at widely separated points in the orbit of the flame; but further observations are needed clearly to explain the effect.

As in the explosive state the flame has extremely little illuminating power, we must conclude that, in the above as well as the following experiments, the obscure intervals mark the periods of explosion, and the bright ones the periods in which the gas burns in the ordinary way with a luminous white flame.

5. *The intermissions of the singing flame are made apparent by a moving object which it illuminates.* While the experiment above described is in progress, the appearance of the horizontal arm of the jet-pipe affords incidentally a pretty proof of the intermittence of the singing flame. As the recurrence of the bright flame between the successive explosions makes this part of the pipe strongly visible, it assumes the aspect of a number of spokes corresponding to the subdivisions of the crown of flame; and if, to vary the effect, we blacken the horizontal arm, and fasten near its outer end, or where it assumes the vertical direction, a brilliant bead of glass or metal, we are presented with a circle of starry points, each of which, by a proper adjustment of the motion, appears to be at rest.

The following proof of the intermitting nature of the singing flame, suggested by the effects just described, is at once so simple and so readily seen at a distance, as perhaps to merit a place among useful lecture-room illustrations. In this experiment the jet-pipe bearing the flame is held at rest in the tube, and the required effect is produced by receiving the light on a circular disc of thick pasteboard or of metal some six inches in diameter, supported near the tube on a horizontal axis, around which it may be revolved by the impulse of the hand. The face of the disc next the tube, coloured of a dead black with paint or a covering of cloth, should have a narrow strip of white paper fastened upon it in a radial direction, or a small circular bit of the same placed near the edge. If both faces are used alternately, we may affix the white bar to one and the dot to the other. On bringing the six-feet tube down over the flame, and giving rapid motion to the disc, we remark that so long as the flame continues silent the bar or dot is quite invisible, but as soon as the sound commences, the black disc becomes diversified by a series of whitish images of one or other of these objects arranged at equal intervals around the central point. It is scarcely necessary to say, that the number of these images, as well as their apparent motion and rest, will depend on the time of rotation as compared with the interval of the explosions of the flame. Should it happen that the period of one revolution of the wheel is precisely that of a certain number of the explosions, neither more nor less, or that of any multiple or submultiple of this number, the images of the bar or dot will continue in each successive rotation to present themselves at the same points, but should such a relation not subsist, these images will be seen to shift their places on the disc, sometimes appearing to advance and at others to retreat.

6. *On the primary source of the vibration of singing flames.*—The preceding experiments, taken in connection with those of Faraday, Wheatstone, Tyndal, and others, afford conclusive proof that *the immediate cause* of these vibrations is to be found in the periodically explosive combustion of the gas. But the important inquiry still remains, *whence arises this periodicity*, why, instead of being uniformly continuous, is the combustion of the singing flame regularly intermitting in its character?

In seeking to account for this peculiarity of the combustion, we are at once led to inquire whether it may not originate in a vibratory motion proper to the jet of gas, independent of its burning. Even were we unprovided with direct proof of such vibratory motion in jets of air, we might, with some probability, infer its existence from the similarity of effects produced on the flames and on water jets by external sounds; and this is the course of argument used in the interesting paper of Professor Le Conte, published in a late number of the "American Journal of Science." But happily we are not left to the guidance of analogies or plausible conjectures in deciding this matter. Some experiments of Savart,* and more recently the elaborate researches of Masson† and Sondhauss,‡ have furnished abundant positive evidence of the vibratory movement of jets of air flowing through small apertures. As these important results appear to have escaped the attention of Professor Le Conte and other late writers on sonorous flames, a particular reference to them may be useful in this place.

Felix Savart, as is well known, demonstrated the existence of vibrations in liquid jets, traced them to their source near or at the aperture, and showed that they were not only susceptible of being variously modified by tones of proper pitch sounded near them, but were capable, under certain conditions, of emitting of themselves distinct musical sounds. He did not, however, stop here, but, in the words of M. Masson, "including all fluids in a general theory, attempted to reproduce with gases the beautiful phenomena which he had demonstrated in regard to liquid jets." According to the same authority, "he showed, by several experiments, that water and elastic fluids present the same phenomena in their efflux." By a method described at length in Daguin's excellent "Traité de Physique" (vol. 1. p. 524), he proved that *a jet of air escaping from a vessel through a small aperture, exhibits a succession of enlargements and contractions in its course similar to those seen in a jet of water.*

These conclusions have since been confirmed and extended by Masson, who, from an elaborate series of experiments, has demonstrated—

First, That the flow of air or gas through an aperture in a metal plate is not continuous, but periodically variable, and that the aperture is the seat of a vibratory movement which produces a sound by acting on the exterior air.

And, *Second,* That the number of vibrations performed by the air at the aperture is directly as the square root of the pressure, and is independent of the diameter of the orifice.

Referring to experiments with sonorous tubes placed in connection with such apertures, Masson has shown—

First, That the sound of a sonorous tube is primarily produced *at the aperture* by the periodically variable flow of air, and

Second, The sound of the aperture is re-enforced by the sonorous tube, when the tone of the latter is exactly or nearly an harmonic of that of the orifice, so that the same mode of vibration may be excited in the tube by very different sounds of the orifice.

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* It appears that these results announced by Savart in his Lectures on Acoustics, in the College de France, were published by Masson in the "Journal d'Institut."

† Annales de Chimie et de Physique, 3e Ser. xl. xli.

‡ Annalen der Physik und Chemie. Band xci.

Among other results bearing upon the present inquiry, this able experimentalist states the important fact, that the vibrations proper to the orifice and those of the column of air in the sonorous pipe react upon each other so as to produce a unison of the different parts of the system, although these separately taken would originate different sounds. It will readily appear that this extension of Savart's well-known principle of the vibration of systems is directly applicable to the phenomena of sonorous flames.

By an independent series of experiments, Sondhauss has been led to similar conclusions as to the mechanical condition of the air-jet, and has furthermore attempted to account for its vibration, as had been previously done by Cagniard-Latour, by the friction of the issuing column against the sides of the aperture. Among various important observations recorded in his elaborated memoir, the following will strike the reader as interesting from its analogy with some of the phenomena of singing flames.

He states that, *on sounding an organ-pipe near the aperture, we observe certain sounds of the pipe to be accompanied by a secondary sound produced by the air jet, which is either in unison with that of the pipe, or an octave below it.* Have we not here an exact counterpart of the beautiful experiment of Tyndal and Schaffgotsch, in which the silent plane is made to sing by sounds of a certain pitch produced in its vicinity? Alluding to this observation of Sondhauss, Masson suggestively remarks, "that the fact seems to him to admit of no other explanation than that which Savart has given of the influence of external sounds on liquid jets."

It should be added, that both Masson and Sondhauss have proved that neither the material of the aperture nor its shape have any influence on the cause which produces the sonorous vibration of the air-jet.

The above brief reference to the discoveries of Savart, and those who have followed in the same line of investigation, is sufficient to show that jets of air under the conditions of these experiments, and doubtless all air-jets, in a degree are, at the moment of efflux, impressed with a vibratory or periodical movement, and that *this is the primary source of the vibration in singing flames.*

In view of these facts, we may describe the principal phases in the production of the singing flame, briefly as follows:—

First, Every jet of gas, and therefore of flame, is at all times the seat of vibratory motion, but, under ordinary circumstances, this is too feeble to produce either audible or visible effects.

Second, When the jet is placed in conditions to favour an explosive combustion, the remissions and intensions of the jet due to the vibratory motion, render the explosions more or less discontinuous, and thus add greatly to the energy of the vibrations.

Third, These vibrations of the explosive flame occurring within a resonant tube of suitable proportions, become accumulated and re-enforced, until, by the mutual reaction of the vibrating-jet and the air-column, a unison is produced corresponding more or less nearly to the fundamental note, or one of the harmonics of the tube.

It thus appears that the vibratory movements of the singing flame are directly traceable to mechanical conditions, which have been *actually* *proved* to exist in air-jets at the moment of their efflux. We are therefore not called upon to resort to conjectural properties of gaseous streams in order to explain them.

As to the mode in which these primary vibrations are excited at the aperture, whether by friction or some other special cause, we are not perhaps prepared, in the existing state of our knowledge, to form a satisfactory theory. But whatever may be their cause, few, I think, will be disposed to explain them by any assumed *cohesive action* of the particles of the gaseous stream. The analogy between jets of air and those of liquids, so far as these vibrations are concerned, has been shown by Masson and Sondhauss to be only partial; but even were it more complete, we could have no difficulty in admitting that the impelling forces, in the one case the elasticity of a pent-up mass of air, in the other the weight of a liquid column, must produce effects in many respects *alike* upon the issuing streams of gas and liquid.

In attempting to apply the theory of liquid jets so beautifully developed by Plateau to jets of gas, we are obliged, with Professor Le Conte, to ascribe to the gaseous molecules a mutual cohesion sufficient to mould the issuing stream into alternating enlargements and contractions; or, in other words, we must suppose them to be actuated by a cohesive force exceeding their repulsion. It is hardly necessary to say, that this assumption is opposed to the unquestionable fact that it is a molecular repulsion which drives the particles through the aperture, and that the same force *acting in the jet* causes it, when received into a vacuum, rapidly to diffuse itself in all directions. The gaseous state is but another name for ponderable matter, composed of self-repellant particles; nor, so long as this state continues, can we conceive the particles to be controlled by the opposite or cohesive power. Taking the view adopted by some, that both these forces are at all times present in gases, we must still allow a great preponderance of repulsion to account for the mechanical properties of the mass. When, by strong compression, the gas is brought near its point of liquefaction, we may conceive this relative preponderance of repulsion to grow rapidly less, and thus to cause the departure from the law of Marriotte which has been observed. But evidently until the molecules are in the act of uniting in the liquid form, repulsion must be their predominating force. The deviation from Marriotte's law marks only a decreasing rate of repulsion, not an efficient energy of cohesion among the particles, *the latter not coming into play until the particles are actually coalescing to form the liquid mass.*

As regards the analogies of shape between sheets of flame and of liquids developed by concurring jets, which have been suggested as indications of gaseous cohesion, it may be remarked, that in both cases the form is doubtless due in great part to the composition of the oblique forces of the concurring jets, and that the resemblance is perhaps further increased by the resistance of the air, producing on the air-jet an effect in some degree the same as that of the mutual cohesion of the parts in the jet of liquid. Indeed, if from such analogies of form we are to infer the control of cohesive force in streams of air, may we not with equal reason, in comparing the eddies and whirlpools of water with the dust-bearing spirals and huge gyrations of the air, ascribe to the latter a cohesive action like that which we know to operate in the corresponding liquid forms?

While thus expressing my dissent from such an application of Plateau's theory of liquid-jets, and from any other view which would ascribe an effective cohesion to matter in the gaseous state, I gladly bear testimony to the clearness with which Professor Le Conte has presented his suggestions in its favour, as well as to the interest of other points in his paper.

Notes on the Progress of Science for the year 1857.—Among the Geographical Expeditions now, or recently in progress, we may mention the following:—That of Lieutenants De Crespigny and Forbes of the British Navy, in the interior of Borneo; and that of Major Burton (the Pilgrim to Mecca), and Captain Speke, in Eastern Africa; the latter carry with them a portable iron boat, and hope to reach the Lake Ngassi.

The expedition fitted out in England for the purpose of exploring both branches of the Niger, by the steam-propeller Dayspring, under the charge of Dr Balfour Baikie, R.N., left the Binue or Kowara River for the Niger, on the 10th of July, and has since been heard from in the far interior. The expedition is composed of fifty Kroomen, twenty-five natives of the countries bordering on the Niger, and fourteen Europeans, including a naturalist, botanist, and engineers. It is the intention to form trading posts on the banks of the river at the most eligible situations for the collection of cotton, shea-butter, and other productions of the interior, provided the climate offers no insuperable obstacles.

Another expedition is now exploring the Congo River. It is commanded by Ladislaus Magyar, of the Portuguese army, accompanied by men of science. His orders are, to make a full survey of that stream.

A scientific expedition for the exploration of the Colorado River of the West, has been recently sent out by the United States Government, under the charge of Lieutenant Ives, commandant, and Dr J. S. Newberry, geologist.

Sir R. I. Murchison, in his annual address for 1856, before the Geographical Society, Great Britain, called attention to a region in British North America, including at least 112,000 square miles, extending from the head-waters of the Assiniboine River to the foot of the Rocky Mountains, and from the northern branch of the Saskatchewan to the 49th parallel of latitude, which has remained almost completely unexplored.

Since then, an expedition, under the auspices of the British Government, commanded by Mr Palliser, Lieutenant Blakiston, R.A., and Dr Hector, has been sent out to explore the above-mentioned territory. The chief objects of the expedition are,—*First,* To survey the waters parting between the basins of the Missouri and Saskatchewan; also the course of the south branch of Saskatchewan and its tributaries. *Secondly,* To explore the Rocky Mountains, for the purpose of ascertaining the most southerly pass across to the Pacific within the British territory. *Thirdly,* To report on the natural features and general capabilities of the country, and to construct a map of the routes.

In July 1857 the party were *en route* to the Saskatchewan River, previous to wintering at Carlton House Fort. The correspondence of Mr Palliser, communicated to the Geographical Society, describes the Falls of

Kakataka, on the White Fish River, as finer in some respects than those of Niagara, being upwards of 171 feet in height. The volume of water, however, is much less. (The most recent notice from Dr Hector is given in the last number of this Journal, page 142.)

The "London Literary Gazette" publishes the following *resumè* of the botanical researches and investigations which have recently been undertaken, or are now in progress, under the auspices of the Government of Great Britain :—

1. Mr Milne, botanist to the surveying voyage of Captain Denham, in H.M.S. Herald, is still pursuing his researches in the South Seas, and especially among the Fejee Islands.

2. Dr H. Fred. Mueller, the able and indefatigable Government Botanist of Victoria, received the appointment of botanist to the Overland Expedition in North Australia, under the command of Mr Gregory. This arduous journey has been happily accomplished in the most satisfactory manner. Dr Mueller has safely returned with his collections. His expenses were borne by the Australian government.

3. Vancouver's Island, and the adjacent coasts of North-West America. Captain Richards, R.N., has lately sailed in H.M.S. Plumper, for the purpose of surveying these countries, which have attracted no small degree of attention since the boundary line between the United States territories and the British possessions in North America has been so fully discussed, and we believe settled. Although no botanist, or express botanical collector, has been attached to the survey, the assistant surgeon, Dr Campbell, and some of the officers, will exert themselves to collect plants; and we know also that a free passage, and every assistance and facility for herborizing on shore, will be offered to a collector, now expected to be at San Francisco, and who has been invited to join the Survey. Vancouver's Island, of very great extent, is said to abound in pines and forest trees.

4. Mr Barter, one of the very intelligent gardeners of the Regent's Park Garden, has been appointed by the Admiralty to accompany Dr Baikie, R.N., in his present ascent and survey of the Kwóra and Binue (formerly considered the Niger and Tsádda); and, from Dr Baikie's familiarity with that river, there is reason to expect that great opportunities will present themselves for increasing our knowledge of this part of tropical Africa, which has been the grave of so many of our scientific explorers.

5. The present of a beautiful steam-yacht, lately sent by the British Government to the Emperor of Japan, it was thought by the Admiralty might be a means of affording facilities for a botanist to penetrate into that little-known country, and they generously offered a passage to a botanical collector, should the Royal Gardens deem it expedient to send one. Mr Charles Wilford, of the Botanical Gardens at Kew, was therefore appointed, and has entered upon the duties of his office. Mr Wilford, when his time for remaining in Japan shall have expired, will be attached to H.M.S. Actæon, for the survey of the coasts of Northern China, and especially Eastern Tartary (or Mantchouria), a *terra incognita* we believe to the European botanist, and likely to yield a very rich harvest.

6. The sixth and last botanical mission we have to notice, is that

which is exploring the south-western territories of the British possessions in North America. The expedition is accompanied by a scientific staff, and the object is, to make researches in the little-known parts of British North America, especially among the Rocky Mountains and towards the United States boundary line, in about latitude 48°.

Much of this country is only known to the Canadian *voyageurs* and Indian hunters: but by far the most interesting region will be a new route across the Rocky Mountains, between the United States boundary and the present only practicable route of the *voyageurs*, in about 55° north latitude. Here the country will be wholly new, and it is hoped the expedition will receive instructions to prosecute their researches as far as the west coast at the Gulf of Georgia, or Straits of De Fuca of the Pacific Ocean.

During the past year, a new expedition, fitted out by Lady Franklin, and under the charge of an experienced Arctic *voyageur*, Captain M'Clintock, has sailed in search of the lost navigators.

A glance at any recent map of the Arctic regions shows, that nearly the whole area east and west of the outlet of the Fish River has been swept by Government searching expeditions. Apart, then, from the fact that the Esquimaux reports point to a very limited locality where the great arctic mystery lies concealed, we are warranted in hoping that a search within an area embracing not more than 370 miles of coast, may be rewarded by the discovery of the Erebus and Terror. Captain M'Clintock proposes to make his way down Prince Regent's Inlet, and thence through Bellot's Strait to the field of search; or, should the ice permit, to proceed direct to it by going down Peel Sound, which he has good reasons for believing to be a strait. If prevented by the ice from passing through Bellot's Strait, or going down Peel Sound, he will abandon the idea of taking his ship through these channels, and, leaving her in safety in Prince Regent's Inlet, will proceed to search for the Erebus and Terror by sledging parties. Captain M'Clintock's primary object will, of course, be, first, the rescue of a single survivor of the Franklin Expedition, if one should exist, as recent reports brought home by whaling captains would tend to show may possibly be the case; secondly, the discovery and restoration of any documents or relics appertaining to the lost expedition; and, thirdly, the verification of the course taken by the Franklin Expedition, and confirmation of the report brought home by Dr Rae, to the effect that in the early spring of 1850, a party from the Erebus and Terror landed a boat on King William's Land,—a fact which in itself establishes the priority of the discovery of a North-West Passage by Sir John Franklin. The locality to be searched is in the immediate vicinity of the North Magnetic Pole, one of the most interesting spots on the face of our globe, which, however, it will be remembered, is not stationary. With the view of taking advantage of the opportunities thus presented for magnetical investigations, the Council of the Royal Society voted a sum of money for the purchase of magnetical and meteorological instruments; and a committee, consisting of distinguished physicists, have supplied Captain M'Clintock with desiderata in magnetism and meteorology, while Sir W. Hooker and Dr Hooker have furnished instructions respecting botanical collections, and supplied Ward's cases for the growth of esculent vegetables.

The following is a summary statement of the recent geographical surveys, planned or executed under the authority of the Russian Government during the last few years :—

The most important has been the exploration of the Amour River. This vast river, which flows through Chinese Tartary, has not hitherto been surveyed, and is very loosely located on even the best maps. It rises in the mountains of Siberia, east of Lake Baikal, and flows eastwardly through the immense district of Mantchouria into the Sea of Ochotsk, in fifty-three degrees north latitude. Its length is 2200 miles, being about as large as the Mississippi. An exploration and scientific survey has been made of Lake Baikal, the largest body of fresh water on the Asiatic continent. It is situated in Southern Siberia, between latitude fifty-one degrees and fifty-six degrees north, and between longitude 103 degrees and 109 degrees east. It is about 370 miles in length, forty-five miles average width, about 900 miles circuit—somewhat larger than Lake Erie. Its depth is very remarkable, as it is surrounded by high mountains. The River Angoria, its outlet, joins the Yenisei River, and flows north until it reaches the Arctic Ocean, making, in its total length, another of the great rivers of the world—some 2600 miles. Through its channel an immense volume of water is emptied into the Bay of Yenisei, and thence into the Sea of Kara, in north latitude seventy-three degrees, east longitude eighty-five degrees, being six degrees thirty minutes within the Arctic circle. Owing to its Arctic outlet, it is impracticable commercially, although it is the largest river flowing into the Arctic Seas from either continent. A survey of the valley of the Maniteh and of the fisheries of the Caspian Sea, has been made by M. Baer. The River Maniteh is 315 miles in length, empties itself into the Don, and so finds its way to the Sea of Azoff.

A geographical and scientific survey of the southern portion of Eastern Siberia is now carried on under the supervision of M. Ousoltseff. Geographical detail in relation to this region has hitherto been little more than a blank.

During the past year intelligence has been received of the murder of Dr Vogel, the successor of Dr Barth, in his explorations in Central Africa. The most authentic accounts relative to his fate have been obtained through the English consul at Khartoum, Upper Nubia, from an envoy of the King of Darfur to the Pacha of Egypt. According to his statement, Dr Vogel (Abdul Wahed) "had departed from Bornu for Berghami, where he was well received, and after having visited all localities as he wished, he proceeded to Madagu, and from thence passed to Borgu, that is to say, Waday, where he met the Vizier of the Prince of Waday, named Simalek, who treated him well. He afterwards entered the interior of that province to the capital city, called Wara, where the Prince Seiaraf, so called Sultan of Waday, who is now paralytic, resides; but in the neighbourhood of Wara there is a sacred mountain, the ascent of which is probibited to all persons. Abdul Wahed (Dr Vogel), whether informed of this or not, ascended this sacred mountain, and when the Prince learned it he ordered him to be put to death, and so it was."

The theory and observations of the Rev. Mr Jones, U. S. N., respecting the zodiacal light, have been published in full during the past year, in one of the volumes of the Report of the U. S. Japan Expedition, and additional confirmatory observations made in 1857 in Quito, S. A., by Mr Jones, were also presented to the American Association. The views of Mr Jones, while they have received the sanction of many astronomers and physicists, are strongly opposed by others, and some very cogent statements in opposition, founded on long-continued observations, have been brought forward by Captain Wilkes, U. S. N. They do not, moreover, seem to find favour with European astronomers, and Professor Piazzi Smyth, in a recent paper before the Royal Society, after opposing the theory, as published in his Japan Expedition Report, closes by saying, that he does not think Mr Jones ever saw the zodiacal light at all.

Father Secchi, the well-known astronomer of Rome, is continuing his researches to determine the rotation of the third satellite of Jupiter; the spots upon it are very visible, but it is not easy to get two observations by which to ascertain the rate of motion in any one evening. He reports a difference in the features of Jupiter from last year. The lowest apparent inferior belt "is a perfect assemblage of clouds, and below this is a very fine line of yellow colour, which appears like a microscopic thread stretched across the planet."

As regards the surface of the moon, on which he has of late bestowed much attention, he thinks he may pronounce the nature of such lunar regions as he has explored (at a distance) to be similar to that of volcanic regions on the earth.

The Annual Prizes awarded by the French Academy for the past year, were principally as follows:*—

The great prize for mathematical science was given to a German, M. Kummer, for his researches on the complex numbers consisting of roots of unity and of whole numbers. One of the grand prizes in physical science was given to Professor Bronn at Heidelberg, for an extensive work made in reply to the following questions:—1. What are the laws of distribution of fossil organized bodies in the different sedimentary strata as regards their order of superposition? 2. What as to their successive or simultaneous appearance or disappearance? 3. What the relations which exist between the present condition of the organic kingdoms and that of earlier time?

Another prize, which had been held out ever since 1847, was given to Lereboullet, Professor of Zoology at Strasbourg. The subject was the following:—*To establish, by studying the development of the embryo in two species, taken, one from among the Vertebrata, and the other, either from the Mollusca or Articulata, the basis for comparative embryology.* The subject was one requiring long investigation, and the Academy awarded a medal of gold, valued at 3000 francs.

The prize in Experimental Physiology was divided between Messrs Waller, Davaine, and Fabre; the first, for his experiments *on the ganglions of the rachidian nerves;* the second, for his experiments *on the Anguillula Tritici;* the third, for *researches on the action of the poison of the Cerceris (Hemenopterous insects) on the nervous ganglionary system of insects.* This is not the place to analyse the interesting researches of these physiologists. But we may say, however, that M. Fabre brought out the fact that the larves, with which the insects of the

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* Derived from the Foreign Correspondence of Silliman's Journal.

Cerceris family provision their nests for the nourishment of their own young, are struck with a kind of paralysis, which permits of their living for a long time, while depriving them of the faculty of feeling or moving. This species of anæsthetic condition is produced by the puncture of one of the thoracic ganglions by the sting of the Cerceris; and M. Fabre has succeeded in producing this condition at will by introducing a little ammonia into the nervous ganglionary system—an effect which he has repeated in other insects.

As usual, the Academy found nothing to compensate or encourage in physics, chemistry, or mineralogy, if we except a prize of 2500 francs, given to M. Schroetter for the discovery of the isomeric state of red phosphorus.

The commission on prizes in medicine distributed upwards of 50,000 francs. The principal recipients were:—

Dr Simpson of Edinburgh, who, as stated by Mr Flourens, first introduced chloroform into anæsthesis for surgical operations.

Dr Middledorp of Vienna (Austria), for the application of the galvano-caustic in certain surgical operations.

M. Brown-Sequard, for having shown that various lesions of the spinal marrow in the Mammalia may be followed after some weeks by a convulsive epileptiform affection, produced either spontaneously or by excitation of the ramifications of the fifth pair of nerves on the side corresponding to that of the lesion.

Mr Delpeach, for making known the accidents occurring among workmen in the India-rubber business from the inhalation of sulphuret of carbon.

The Cuvierian prize, which is assigned every three years to the author of works in Natural History, was given to Professor Richard Owen, who for more than twenty years, through works of great number and elevated character, has contributed largely to comparative anatomy and palæontology. This prize was first given to Professor Agassiz, for his work on fossil fishes, and the second time to Professor Müller of Berlin, for his researches on the structure and development of Echinoderms.

It is thus seen that in this year, as in others preceding, *foreign* men of science have taken a large part of the prizes, a fact highly honourable to the Academy of Sciences, showing that a right to its munificence does not rest in being a Frenchman, but in being worthy of it through actual labours.

The number of well-endowed Meteorological Observatories is gradually increasing. The Pope has recently authorized the formation of one at Rome, and has contributed liberally towards the expense of constructing it, and of providing it with the necessary instruments. The Captain-General of Cuba has also decreed that one shall be established on that island, under the direction of Mr Poey, the well-known meteorologist.

The Paris Observatory now receives meteorological observations every day from fourteen stations in France and seven in foreign countries. The foreign stations are Madrid, Rome, Turin, Geneva, Brussels, Vienna, and Lisbon. Now that telegraphic communication has been established between France and Algeria, meteorological observations from districts of Northern Africa will also be included.

The sum of 15,000 dols. has been donated to Iowa College by Mr

Charles Hendrie, for the ultimate purpose of establishing and endowing a school in that institute, similar to the "Lawrence Scientific School in Harvard University."

The French Government has recently created a new chair in the Museum of Natural History at Paris, under the name of "Vegetable Physics," and has appointed to it M. G. Ville, who has distinguished himself by his researches on the absorption of nitrogen by plants.

The new professor will have, it appears, specially to occupy himself with such matters relative to vegetable production as do not fall strictly within the domain of botany, the cultivation of the soil, and agricultural chemistry.

The sum of two thousand five hundred dollars was appropriated at the last session of Congress "to enable the Secretary of the Treasury to cause such experiments and analyses of different beds of ore as to test whether any such ores, in their native state, possess alloys that will resist the tendency to oxidize to a greater extent than others, and to ascertain under what circumstances they are found, and where, in order to facilitate the proper selections of iron for public works." To carry out the object in view, the Secretary states in his recent Report, "that he has caused circulars to be sent to all iron-masters whose names could be ascertained, soliciting specimens of ore and iron, and calling for information pertinent to the subject, and that, in compliance with the request, a large number of specimens have been received.

"So soon as the specimens are all received and arranged, and the information which accompanies them has been abstracted and collated, a competent chemist or metallurgist will be employed to make the experiments and analysis. Conclusive evidence has already been received that a decided difference in the susceptibility of different irons to oxidize does exist, and it is hoped that the proposed analysis will discover the cause. However, should the experiments fail in this respect, they will at least show the localities from which the least oxidizable iron can be procured."

The late M. Michaux, the distinguished botanist, author of the "Sylva Americana," bequeathed by will, to the Massachussetts Agricultural Society, 8000 dols., for the purpose of promoting Sylvaculture and Horticulture, and of making experiments on the growth of trees in sandy rocks and bog soils. The principal portion of the bequest is to be invested for increase in good farm land; cheap and productive land is to be purchased with another portion, and the remainder to be appropriated to seeding and planting the experimental plantations.

A larger sum than the above was also bequeathed to the Philadelphia Academy of Natural Science, for similar purposes.

In accordance with a joint resolution of Congress, passed in 1857, to provide for ascertaining the relative value of the coinage of the United States and Great Britain, and fixing the relative value of the coins of the two countries, Professor Alexander of Baltimore has been appointed Commissioner to confer with the proper functionaries in Great Britain, in relation to some plan or plans of so mutually arranging, on the decimal basis, the coinage of the two countries, as that the respective units shall hereafter be easily and exactly commensurable.

The researches of M. Ville, of France, on the absorption of the nitrogen of the atmosphere by plants during vegetation still continue. The importance of these researches may be best understood by the fact, that the French Academy has voted a sum of 4000 francs, the half as an indemnification for the expense of his past experiments, the other 2000 francs for continuing his labours. The subject is still in much obscurity, and the issue of further experiments must be awaited. M. Liebig holds that the azote of plants is entirely derived from ammonia, and that there is no direct absorption of the azote of the atmosphere, against which opinion some of M. Ville's researches seem to militate.

The Institute of British Architects announce, as subjects for future prizes :—" The Application of Wrought-Iron to Structural Purposes ;" " The Influence of Local Materials on English Architecture ;" and they promise a tangible honour " for the best design in not less than five drawings, for a marine sanitarium, or building for the temporary residence of a limited number of convalescents belonging to the middle and upper classes of society."

M. Milne Edwards, of Paris, has completed the first volume of his great work, " Leçons sur la Physiologie et l'Anatomie Comparée de l'Homme, et des Animaux." It is a full exposition of the state of these sciences at the present time, and of the progress they have made since Cuvier wrote on them.

Professor Harvey, the English Algologist, has now in press, as the result of his Australian expedition, an illustrated marine botany of Australia. The work will contain coloured illustrations, and descriptions of three hundred of the more characteristic and remarkable species. This number will allow for the full illustration of all the Genera, and of the principal sub-types composed within each Genus.

The first part of the second volume of the Annals of the Observatory of Harvard College, published during the past year, relates wholly to Saturn, and contains the observations made at the observatory by William C. Bond, Director of the Observatory. The general results have been before the public for some time, and their high merits is well known. The observations are brought down to May of the present year. The series of plates contain 120 figures representing the appearances of Saturn and the ring at as many different times of observation.

The celebrated Mezzofanti library has been purchased by the Pope, principally out of his own privy purse, and munificently presented to the Bologna public library. The collection consists of several thousand volumes, principally classical and oriental works, and contains grammars, dictionaries, and educational books alone, in eighty different languages and dialects. The Bologna library, which has had the good fortune to acquire this treasure, possesses already about one hundred and forty thousand volumes, many of which are very rare.

A continuation of Ehrenberg's great work has been recently issued, consisting of eighty-eight pages large folio : and it relates exclusively to North America. It consists of descriptions of earths and river sediments, from different sections of the country, as regards their infusorial contents, and tables of the results for each. The parcels examined and here described amount to two hundred and forty-seven, eighty-five of which are from Texas, four from Arkansas, and thirty-six from the Washita and Neosho, &c. The number of microscopic species observed by Ehrenberg and Bailey in the Southern United States, is eight hundred and fifty-five; of these one hundred and forty-eight are brackish water and marine species, about half of them being fossil and half living.

An interesting contribution to our knowledge of Organic Morphology has been made during the past year by Mr John Warner of Pottsville, Pa. This name is used to designate that branch of science which seeks to explain organic forms upon mathematical or mechanical principles. The subject has attracted much attention in Europe, but has received but little notice in this country. Mr Warner's contribution consists of a pamphlet, illustrated by nearly two hundred engravings, containing an account of the labours of foreign Physicists in this field, besides some original formulæ for the construction of curved lines, accompanied with the figures of the curves themselves, and of the organic forms which they resemble.

It is worthy of notice, that the author has succeeded in bringing the curves representing, at least approximately, the types of, first, the egg, and then of several organic forms, under one general equation, the relation of which to the revolving orbit of Newton, and to the curves of Grandus, is also shown. This, we believe, is a new result. The curves of Grandus had long been forgotten and neglected; Mr Warner is, we believe, the first to notice them in connection with Morphological history, as also to introduce some other historical matter gleaned in the field of Mathematics. As the author declines to speculate on the manner in which the vital forces may cause matter to assume the forms represented by his curves, we shall not undertake to supply what may be needed in this respect. We would say, however, that the subject promises to continue to engage the attention of Physicists, and we incline to the belief, which the author appears to entertain, that Organic Morphology will one day become a strict science.

The third volume of Observations made at the Magnetical and Meteorological Observatory at Toronto, Canada, under the general superintendence of General Sabine, R.A., has been published during the past year by the British Government.

The main body of the work is occupied by a record of the observations; but General Sabine has appended to the apparently dry figures, a chapter, entitled "Comments and Conclusions," which contains many interesting remarks and curious deductions. It has been found that, in the north-solstitial months, easterly disturbances preponderate, and in the south-solstitial months, westerly predominate. The equinoctial months are the epochs of maximum disturbance, and the solstitial months epochs of minimum disturbance. It has also been discovered that the occurrence of the larger disturbances of the vertical force at Toronto is governed by periodical laws depending on the hours of solar time. The aggregate value of the disturbances in the five years is a maximum at 3 P.M., and a minimum at 11 A.M. There is also a secondary maximum at 5 P.M., and a secondary minimum at 9 P.M.

The three magnetic elements concur in showing that the moon exercises a sensible magnetic influence at the surface of the earth, producing in every lunar day a variation in each of the three elements; but by far the most interesting discovery connected with terrestrial magnetism is the curious accordance between intense magnetic disturbance and spots on the sun. These spots have been observed to increase and decrease in number and intensity decennially, and it appears that the periodical magnetical inequality has its opposite phases of maximum and minimum separated by an interval of five years, of which the cycle might therefore be conceived to include about ten of our solar years. Respecting this remarkable circumstance, General Sabine observes:—

"Had no other circumstance presented itself to give additional interest to an investigation which held out at least a fair promise of making known laws of definite order and sequence in phenomena which have excited so much attention of late years, but of which so little has hitherto been ascertained,—had, for example, the decennial period which appeared to prevail with precisely corresponding features in two distinct classes of the magnetic variations, connected itself with no other periodical variation either of a terrestrial or cosmical nature with which we are acquainted,—there might have been, indeed, little reason to apprehend, in these days of physical curiosity and inductive application, that the investigation would have been suffered to drop; but the interest has doubtless been greatly enhanced by the remarkable coincidence between the above-described periodical inequality, by which the magnetic variations referable to solar influence are affected, and the periodical inequality which has been discovered by M. Schwabe to exist in the frequency and magnitude of the solar spots. The coincidence, as far as we are yet able to discover, is absolute; the duration of the period is the same, and the epochs of maximum and minimum fall in both cases on the same years. The regularity with which the alternations of increase and decrease have been traced by M. Schwabe in his observations of the solar spots (which have been now continued for about thirty years), must be regarded as conferring a very high degree of probability on the systematic character of causes which as yet are known to us only by the visible appearances which they produce on the sun's disk, and by the disturbances which they occasion in the magnetic direction and force at the surface of our globe. As a discovery which promises to raise terrestrial magnetism to the dignity of a cosmical science, we may feel confident that, although the colonial observatories have been brought to a close, the investigations which they have thus successfully commenced will be pursued to their proper accomplishment in those national establishments which have a permanency suitable for such undertakings."

It is evident that the former supposed analogy between magnetical and atmospherical disturbance must now be abandoned, and that we must seek in more distant sources than those of meteorological phenomena for the causes of magnetical disturbances. It can only be, however, by the aid of long-continued and patient observations that the philosopher will be enabled to deduce magnetical laws, which it is not too much to assert will be found among the most interesting in the whole range of physical science. For, as Bacon remarks, "Physical knowledge daily grows up, and new actions of nature are disclosed,"—and it is quite certain that it is the duty of all civilized nations to take an active part in extending physical science, which enters largely into a country's glory and prosperity.—(*American Annual of Scientific Discovery*, 1857.)

New and Curious Guano Product.—At a recent meeting of the Boston Society of Natural History, Dr A. A. Hayes exhibited some specimens resembling the trachyte rock so closely that most observers would have mistaken them for trachyte.

The specimens consisted of hand specimens, having the uneven fracture of trachyte, full of capillary passages, with some cavities; there were fractured planes of brown and flesh-coloured minerals, resembling felspar, and some small red, brown-coloured and black granules; but the most characteristic mark was the occurrence of angular fragments and grains of yellowish-green colour, hardly distinguishable from *epidote* by the eye. The external surface was brown and uneven, like that of a weathered basalt or trap. The island from which these specimens came has been examined by a geologist, and from the prevalence of this rock, it is said that he pronounced the island to be of volcanic origin. A mass was sent to Dr Hayes, and he found it had structural planes, the divisions producing trapezoidal masses, their surfaces and the lines marked by darker colours, and, so far as could be determined, there was evidence of the mass being part of a rock formation of some extent.

The chemical composition discloses the remarkable fact, that this rock is composed essentially of fish-bones and altered shells, which have passed through the alimentary canals of sea-fowls. Referring to communications before made,* Dr Hayes stated that the organic matter of fish bones in the droppings of fowl, reacts on the bone phosphate of lime, to eliminate acid salts of phosphoric acid, and these cement other portions, or decompose shells, which are composed of carbonate of lime and animal tissues. The felspar-like granules are generally compact, coloured portions of converted shells, having a crystalline form, and there are aggregates of ferruginous and aluminous phosphates, arising from the same kind of action on ferruginous matter, which, in the form of a fine clay or volcanic ash, has been brought within the sphere of the action of the acid phosphates. The cavities sometimes present minute crystalline facets of phosphate of lime crystals, while the capillary channels and pores, which give the trachyte-like character, are really the passages through which the carbonic acid and other gases escaped during the transformation of the organic matter, precisely as they occur in basalt and trap, where igneous action has been supposed to have been influential.

This rock is covered more or less by Atlantic guano rock, presenting the variety which consists of compact light-coloured phosphate of lime, containing about twenty parts in one hundred of carbonate of lime, and in some parts is a consolidated shell-bank; the recent shells and coral fragments being visible. Where, through time and favourable exposure, the bone remains have thoroughly decomposed the shells, hand specimens would be mistaken for the flesh-coloured, massive phosphate of lime of New Jersey. These more or less well-cemented and altered rocks are also connected with still more recent deposits, retaining even the odorous animal remains of oily acids; and the whole formation, above that of the trachytic form of rock, contains the remains of infusoria.

Thus a small island of the Atlantic, lying about eighteen degrees north of the equator, presents us with an epitomized succession of rock strata, formed from materials which, once endowed with life, have served to nourish other living systems, and then given rise to chemical changes resulting in the production of various mineral solids which remain.

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* See Annual of Scientific Discovery for 1857, pp. 242, 243, 244.

The trachyte-like rock forming the basis rock of this island, theoretically, may have received its geological and chemical characters in ocean water. A subsidence of the land, after its surface had been deeply covered with organic remains, would allow of that aqueous action of decomposition and cementation which we notice, and the subsequent desiccation would explain the natural divisions by rents. The formation of silicates of iron, manganese, and alumina from phosphates of lime, is a mineralizing process which can take place in ocean water by infiltration, volcanic ashes, or divided materials of plastic rocks being present, as analysis shows them to be. The rock is hydrous, losing nearly ten per cent. of its weight by ignition, or—

Water with a little organic matter, . .	10·00
Bone Phosphate of Lime, ...	85·20
Carbonate of Lime, ...	3·00
Oxides Iron, Manganese, and Alumina, . .	5·22
Silicic Acid and Sand, ...	1·78
	105·20

The excess of weight being due to the estimation of the phosphoric acid united to lime as bone phosphate of lime, while truly part of it, with a portion of silica, is united to the oxides present.

These facts prove that mineral masses containing phosphate of lime may be thus formed from animal phosphate of lime, and present all the characters which we recognise in the phosphate of lime contained in the oldest slates. Additional interest has been given to this subject by the investigations of Professor Booth of Philadelphia, and Dr Piggott of Baltimore, who have analyzed specimens in which the phosphoric acid had combined with both oxide of iron and alumina.—(*American Annual of Scientific Discovery*, 1857.)

On the Sugar of the Sorghum Saccharatum, *or Chinese Sugar-Cane.*—At a late meeting of the Boston Society of Natural History, Dr. A. A. Hayes read a paper upon the kind of sugar developed in the *Sorghum saccharatum*, or Chinese Sugar-Cane, as follows:—

The introduction of this interesting plant has led to many somewhat extravagant suggestions in relation to its future bearing on the agriculture and commerce of our country, particularly in relation to its produce of sugar. I have therefore deemed it a subject worthy of chemical observation and experiments, to determine its claims as a sugar producer; and have also chosen it to illustrate a uniformity of vegetable secretion, according with well-known natural laws. In order to give scientific precision to the remarks which follow, it is necessary that a brief definition of the term sugar should be given. So rapidly has chemical science progressed of late, that this well-known term has now become a generic name for a class of bodies, individually presenting us with the most marked diversities of sensible characters and composition. We have sugars which are sweet, others which are slightly sweet, and some destitute of sweetness; some are fermentescible, others do not undergo this change; some are fluid, more are solid.

In connection with the present subject, adopting cane sugar as the most important kind commercially, and as an article of food from certain inherent qualities, if we examine into its sources, we find them abundant but not numerous. So far as observation has extended, its production by a plant is definite; a change of locality, even when accompanied by a marked change in the habit of the plant, does not alter essentially the nature of the sugar it produces. Thus the cane of Louisiana rarely matures and is an annual, while in the soil and climate of Cuba, it enjoys a life of thirty or even sixty years. The juice of our southern plant always contains more soluble alkaline and earthy salts than is found in the cane of Cuba, but its sugar is secreted as cane sugar. The juice of the sugar-beet, of water-melons, and a large number of tropical fruits, the sap of the maple and date palm, afford cane sugar. In these juices and saps, when concentrated by desiccation in the cells of the plants, it always appears in regular, brilliant crystals, of a prismatic form, clear and colourless; distinctly indicating a vital force in the plant, separating it from other proximate principles, and leaving it in its assigned place pure.

The class of sugars next in importance includes, under the general term Glucose, a number of sugars having varied characters, which should be separately grouped. Among them are the sugars of fruits, seeds, and grasses; those produced in the animal system, and the artificial sugars made from starch, grains, and sawdust. The varieties of glucose are both solid and semifluid. When solid, they present aggregates of sub-crystalline form, in which the organic tendency to rounded surfaces is generally seen. The semifluid forms often manifest a disposition to become solid on exposure to air, and they then experience a molecular change, which produces crystals having new relations to polarized light, and different physical and chemical characters.

It is unnecessary to enter more minutely at this time into a description of each variety of glucose, for the individuals of the class are easily distinguished from each other, and most clearly and remarkably from cane sugar. The plants producing the natural glucose sugars mature their cells as perfectly as those producing cane sugar, and the secretion can be found as distinctly isolated from other principles as cane sugar is, even when the glucose is semifluid. Hence we are able to determine by microscopical observations, aided by chemical tests, the presence and kind of sugar in the tissues or sap of a plant, often without incurring the risk of change of properties through the chemical means adopted for withdrawing the sugar.

As the *Sorghum saccharatum* belongs to the Gramineæ, we should expect to find its saccharine matter the variety of glucose called sugar of grasses, or fruit sugar. The unsuccessful attempts made to crystallize sugar from the juice of the Sorghum produced in different climates of our country last year, indicated that it contained no cane sugar, or that the presence of some detrimental matter in the expressed juice destroyed the crystallizable character of cane sugar, as can be artificially done. My observations commenced after I had obtained several specimens of the Sorghum, and have been continued on the semifluid sugar, likewise from different parts of the United States, with uniform results.

When a recent shaving of the partially-dried central cellular tissue of the matured stalks of the Sorghum is examined by the microscope, we observe the sugar cells filled with semifluid sugar. After exposure to air, it is often possible to distinguish some crystalline forms in the fluid sugar. These grains, after being washed, cease to present a clear crystalline character, and have the hardness and general appearance of *dry fruit sugar.* By withdrawing the sugar without the aid of water, it is possible to obtain it colourless and neutral, as a semifluid glucose or fruit sugar, and no traces of crystals or crystalline forms can be seen. The glucose thus obtained, freely exposed to air, soon undergoes the molecular change which is exhibited by sugar of grapes, and we thus observe another character associating the whole product with the sugar of grasses and fruits. Leaving the physical observations, and substituting the more exact processes of the laboratory, I found that the semifluid sugar of the Sorghum did not blacken in sulphuric acid, but was sensitive to the action of alkalies, and reduced the alkaline solution of tartrate of copper, thus conforming to the well-known characters of glucose. The most careful trials I could make failed in detecting cane sugar in any samples of the Sorghum stalks, or in the samples of sugar, including one made by Colonel Peters in Georgia, prepared under the most careful management. I must therefore conclude, *that the Sorghum cultivated in this country does not secrete cane sugar or true sugar, its saccharine matter being purely glucose in a semifluid form.*

As a matter of science, this result is interesting, as showing the integrity of character pertaining to the genus in which this plant is botanically placed; the sweet-grasses yielding fruit sugar, while the maize produces cane sugar only.

In its economical bearings we might wish that the Sorghum secreted cane sugar, for the values of cane sugar and glucose are very different. From the best authorities we learn that the power of imparting sweetness in cane sugar is between two and a half and three times as great as that of dry glucose; and, the semifluid sugar of the Sorghum containing water, nearly four pounds of this will be required to equal one pound of sugar in ordinary use. As a raw material for the production of spirit, for which it seems well adapted, the glucose of the Sorghum may prove valuable, and as an addition to a forage crop, the plant may be found to possess a high agricultural importance.

Dr John Bacon made a statement confirmatory of the results arrived at by Dr Hayes. He was unable to obtain any crystals of cane sugar.

A private note of Dr Hayes, received by the editor since the communication of the above paper, states that the *glucose sugar of the Sorghum,* after extraction, and standing several months, takes a crystalline form. The crystals formed resemble those of cane sugar, but the product itself remains a higher grade of dry fruit sugar.

Dr Hayes also states that the Sorghum, when grown in Algeria, undoubtedly secretes *cane sugar*—the climatic influences being altogether different from those to which the plant is subjected in the United States. —(*American Annual of Scientific Discovery,* 1857.)

Ammonia in Dew.—M. Boussingault has communicated to the Academy of Sciences of Paris some interesting determinations as to the quantity of ammonia contained in dew. The dew collected on six different nights between the middle of August and the end of September, at Liebfrauenberg, contained on an average 4·92 milligrammes per litre (about 0·3 grain per gall.) This shows the nutritive effects of heavy dews. M. B. also showed how this ammonia was absorbed by porous substances. The following substances, pulverized and exposed to the air for two or three days, absorbed the amounts of the gas noted:—

Brick,	0.0000005	Sand,	0·0000008
Phosphate of lime,	0·0000008	Wood, charcoal,	0·0000029

Repeating his experiments in Paris, obtaining the dew artificially by condensing the moisture of the air upon a cold cylinder of metal, he obtained 10·8 mm. per litre (or 0·66 gr. per gall.) of ammonia, and traces of nitric acid. This experiment shows that the atmosphere of our cities is more strongly charged with ammonia than that of the country.—(*American Annual of Scientific Discovery*, 1857.)

On a New Source of Electrical Excitation.—The following paper, by Mrs Elisha Foot, was presented to the American Association for the Advancement of Science at its last meeting:—I have ascertained that the compression or the expansion of atmospheric air produces an electrical excitation. So far as I am aware this has not been before observed, and it seems to me to have an important bearing on the explanation of several atmospheric and electrical phenomena. The apparatus used was an ordinary air-pump of rather feeble power, and adapted either to compress or exhaust the air. Its receiver was a glass tube about twenty-two inches in height and three in diameter, with its ends closed by brass caps cemented to it. At the bottom was a stop-cock and a screw, by which it was attached to the air-pump. To the top were soldered two copper wires, one hanging down within the tube, terminating in one or more points, and extending to within about six inches of the bottom, the other extending from the upper side of the cap to an ordinary electrical condenser. In experimenting after compressing or exhausting the air within the receiver, the wire reaching to the condenser was disconnected from it. The upper plate was lifted from its place by its glass handle, and its electrical condition tested by a gold-leaf electrometer. I have found it convenient first to compress the air and close the stop-cock, when the condenser would be found to be charged with positive electricity. Then after discharging all traces of it both from the condenser and the wire leading to it, the air was allowed to escape, and the condenser would become re-charged to an equal extent. My experiments with this apparatus have extended over about eight months, and I have found the action to bear a strong analogy to that of the electrical machine. In damp or warm weather little or no effect would be produced, whilst at other times, particularly in clear cold weather, the action would be so strong as to diverge the leaves of the electrometer to their utmost extent. In warm weather, when no action would be produced, I have attained the result by cooling the air artificially. A sudden expansion or contraction always increases the effect. The results with oxygen gas were similar, but I was not successful with either hydrogen or carbonic acid gases. It is believed that the results which have been obtained on a small scale in my experiments may be traced in the great operations of Nature. The fluctuations of our atmosphere produce compressions and expansions sufficient to cause great electrical disturbances. Particularly should this be observed in the dry cold regions of our atmosphere above the effects of moisture and vapours; and it was established by the experiments of Becquerel, as well as those of Gay-Lussac and Biot, that the electricity of the atmosphere increases in strength with the altitude. A manifest relation, moreover, between the electricity of the atmosphere and the oscillations of the barometer has frequently been observed. Humboldt, treating upon the subject in his "Cosmos," remarks, among other things, that the electricity of the atmosphere, whether considered in the lower or the upper strata of the clouds in its silent problematical diurnal course, or in the explosion of the lightning and thunder of the tempest, appears to stand in a manifold relation to the pressure of the atmosphere and its disturbances. The tidal movements of our atmosphere produce regular systematic compressions twice in twenty-four hours. These occur with so much regularity within the tropics, as observed by Humboldt, that the time of day is indicated within fifteen or twenty minutes by the state of the barometer. And Saussure observed a diurnal change in the electricity of the atmosphere corresponding with the diurnal changes of the barometer. The electricity of the atmosphere, he observes, has therefore a daily period like the sea, increasing and decreasing twice in twenty-four hours. It, generally speaking, reaches its maximum intensity a few hours after sunrise and sunset, and descends again to its minimum before the rising and setting of that luminary.—(*American Annual of Scientific Discovery*, 1857.)

Improvement in House's Telegraph.—An improvement, known as Baine's Printing Telegraph, has been effected on House's instrument. The main parts of House's machines are type-wheels, which are made to revolve alike at the different stations, so that when they are all stopped at the same instant by breaking the current, the same letter is, at every place, in front of the instrument. Sometimes one wheel gets in advance of the others, and remains so until put back by the operator. This getting out of register is obviated in the new improvement by giving the type-wheels a vibrating motion. After telegraphing each letter, these wheels come back to the starting point, so that if the machine makes an error it is confined to one letter. In another part of the arrangement, denominated the mutator, which is in the main telegraphic circuit, there is such a combination with a permanent electro-magnet, that the greatest of all difficulties in stormy weather, that of adjusting the magnet, is removed, as the mutator is self-adjusting to a great extent. and a line of telegraph can be successfully operated by its use when all other magnets are unmanageable. The inventor expects that these instruments, in addition to the ordinary employment, will be extensively used by newspaper offices, merchants, and brokers, as they require no skill in handling, and cost but little.—(*American Annual of Scientific Discovery*, 1857.)

On the Disposition of Force in Paramagnetic and Diamagnetic Bodies.—The following is an abstract of a lecture on the above subject, recently delivered before the Royal Institution of Great Britain by Professor Tyndall, F.R.S.:—The motion of an attractive force, which draws bodies toward the centre of the earth, was entertained by Anaxagoras and his pupils, by Democritus, Pythagoras, and Epicurus; and the conjectures of these ancients were renewed by Galileo, Huyghens, and others, who stated that bodies attract each other as a magnet attracts iron. Kepler applied the notion to bodies beyond the surface of the earth, and affirmed the extension of this force to the most distant stars. Thus it would appear, that in the attraction of iron by a magnet originated the conception of the force of gravitation. Nevertheless, if we look closely at the matter, it will be seen that the magnetic force possesses characters strikingly distinct from those of the force which holds the universe together. The theory of gravitation is, that every particle of matter attracts every other particle; in magnetism also we have the phenomenon of attraction, but we have also, at the same time, the fact of repulsion, and the final effect is always due to the difference of these two forces. A body may be intensely acted on by a magnet, and still no motion of translation will follow, if the repulsion be equal to the attraction. A dipping needle was exhibited; previous to magnetization the needle, when its centre of gravity was supported, stood accurately level, but after magnetization one end of it was pulled towards the north pole of the earth. The needle, however, being suspended from the arm of a fine balance, it was shown that its weight was unaltered by its magnetization. In like manner, when the needle was permitted to float upon a liquid, and thus to follow the attraction of the north magnetic pole of the earth, there was no motion of the mass towards the pole referred to; and the reason was known to be, that although the marked end of the needle was attracted by the north pole, the unmarked end was repelled by an equal quantity, and these two equal and opposite forces neutralized each other as regards the production of a motion of translation. When the pole of an ordinary magnet was brought to act upon the swimming needle, the latter was attracted,—the reason being, that the attracted end of the needle being much nearer to the pole of the magnet than the repelled end, the force of attraction was the more powerful of the two; but in the case of the earth, the pole being so distant, the length of the needle was practically zero. In like manner, when a piece of iron is presented to a magnet, the nearer parts are attracted, while the more distant parts are repelled; and because the attracted portions are nearer to the magnet than the repelled ones, we have a balance in favour of attraction. Here, then, is the most wonderful characteristic of the magnetic force which distinguishes it from that of gravitation. The latter is a simple unpolar force, while the former is duplex or polar. Were gravitation like magnetism, a stone would no more fall to the ground than a piece of iron towards the north magnetic pole; and thus, however rich in consequences the supposition of Kepler and others may have been, it was clear that a force like that of magnetism would not be able to transact the business of the universe.

The object of the evening's discourse was to inquire whether the force of diamagnetism, which manifested itself as a repulsion of certain bodies by the poles of a magnet, was to be ranged as a polar force beside that of magnetism, or as an unpolar force beside that of gravitation.

By means of a beautifully-devised piece of apparatus, which cannot well be explained without a diagram, Professor Tyndall was enabled to experimentally prove that the force of diamagnetism was a polar force, precisely antithetical to the force of magnetism. The diamagnetic substance operated on in the first instance was bismuth, but the same action was found to take place with various other substances, as phosphorus, nitre, sulphur, calcareous spar, statuary marble, &c.; each of these substances was proved polar, the disposition of the force being the same as that of bismuth, and the reverse of that of iron. When a bar of iron is set erect, its lower end is known to be a north pole, and its upper end a south pole, in virtue of the earth's induction. A marble statue, on the contrary, has its feet a south pole, and its head a north pole; and there is no doubt that the same remark applies to its living archetype, each man walking over the earth's surface is a true diamagnet, with its poles the reverse of those of a mass of magnetic matter of the same shape and in a similar position.—(*American Annual of Scientific Discovery*, 1857.)

Of the Development of Heat in Agitated Water.—Mr G. Rennie, in a communication to the British Association on the above subject, stated that the subject of the mechanical or dynamic force required to raise a given quantity of water one degree of Fahrenheit, had long been the object of the research of philosophers, ever since Count Rumford, in his celebrated experiments on the evolution of heat in boring guns when surrounded by ice or water, proved the power required to raise one pound of water one degree, and which he valued at the dynamic equivalent of 1034 lbs. M. Moya was the first who announced that heat was evolved from agitated water. The second was Mr Joule, who announced that heat was evolved by water passing through narrow tubes, and by this method each degree of heat required for its evolution a mechanical force of 770 lbs. Subsequently, in 1845 and 1847, he arrived at a dynamical equivalent of 772 lbs. These experiments had since been confirmed by other philosophers on the Continent. In the present paper, Mr Rennie stated that his attention was called to the subject by observing the evolution of heat by the sea in a storm, and by the heat from water running in sluices. He therefore prepared an apparatus similar to a patent churn, somewhat similar to that adopted by Mr Joule, but on a large scale. In the first case, he experimented on fifty gallons, or 500 pounds of water, inclosed in a cubical box, and driven by a steam engine instead of a weight falling from a given height, as in Mr Joule's experiment; secondly, on a smaller scale, by ten pounds of water inclosed in a box. The large machine or churn was driven at a slow velocity of eighty-eight evolutions per minute, and the smaller machine at the rate of 232 evolutions per minute, so that the heat given off by the water in the large box was only at the rate of three and a half degrees per hour, including the heat lost by radiation; whereas the heat evolved by the ten gallons of water contained in the small box, agitated at 232 evolutions, was 56 degrees Fahrenheit per hour. Thus the temperature of the water in the large box was raised from 60 degrees to 144 degrees, and the temperature of the water in the small box to boiling point. As an illustration, an egg was boiled hard in six minutes. The mechanical equivalent, in the first case, was found to approximate nearly to that of Mr Joule, but in the latter case it was considerably above his equivalent, arising, very probably, from the difficulty of measuring accurately the retarding forces.—(*American Annual of Scientific Discovery*, 1857.)

The Opthalmoscope.—An instrument called the Opthalmoscope, by the aid of which the human eye may be internally examined, has recently been brought to the notice of the scientific world. The instrument is in the form of a concave mirror, with a hole in the centre, in which a lens is inserted; to this another lens is added, which, however, is separate and moveable. When the instrument is used, a lighted candle is placed by the side of the patient. The concave mirror is then held in front of the eye to be examined, while the moveable lens is suspended between the light and the mirror, in such a manner as to concentrate the rays of the first on the second. The reflected rays converge on the retina, and on passing through it diverge and render luminous the whole interior of the eye, which the observer can see by looking through the lens placed in the mirror's centre. The retina and the lens form a microscope, the multiplying power of which is about 500.—(*American Annual of Scientific Discovery*, 1857.)

Rapidity of Thought, or Nervous Action.—The method of transforming the valuation of time into space by the rapid revolution of a cylinder, proposed by Mr Fizeau, has been applied to the measurement of the rapidity of nervous impulse. Such a cylinder rotating 1000 times a second, and divided into 360 degrees, may measure 1–360,000th part of a second; or rotating 1500 times a second, 1–540,000th part of a second; and even this may be subdivided by a microscope, so as to obtain the ten-millionth, or perhaps 100-millionth part of a second. By this extreme minuteness of subdivision of time, it is not difficult to measure even the rapidity of a nervous impulse. If an electric shock be given to the arm, it produces a sensation and a contraction of the muscles. Hence, by noting the interval of time between the shock and the contraction, the time occupied by the transmission of the sensation and the action of the brain, however quick, will be determined. By trying the experiment with different parts of the body, sensible differences have been observed, the shock applied to the thumb being one-thirtieth of a second behind that applied to the face; and this difference pertains to the transmission and not to the action of the brain, and hence enables us to eliminate the latter in the experiments. In this way it has been found by M. Helmholtz, by whom these experiments have been made with the most care,—1. That sensations are transmitted to the brain at a rapidity of about 180 *feet per second*, or at one-fifth the rate of sound; and this is nearly the same in all individuals. 2. The brain requires *one-tenth of a second* to transmit its orders to the nerves which preside over voluntary motion; but this amount varies much in different individuals, and in the same individual at different times, according to the disposition or the condition at the time, and is more regular the more sustained the attention. 3. The time required to transmit an order to the muscles by the motor nerves is nearly the same as that required by the nerves of sensation to pass a sensation; moreover it passes nearly one-hundredth of a second before the muscles are put in motion. 4. The whole operation requires one and a quarter to two-tenths of a second. Consequently, when we speak of an active, ardent mind, or of one that is slow, cold, or apathetic, it is not a mere figure of rhetoric.—(M. Ule, *Revue Suisse.*)

On the Spirality of Motion in Whirlwinds and Tornadoes.—The following important paper was read before the American Association for 1856 by the late W. C. Redfield, and subsequently published in "Silliman's Journal:"—1. An aggregated spiral movement around a smaller axial space constitutes the essential portion of whirlwinds and tornadoes. 2. The course of the spiral rotation, whether to the right or left, is one and the same in this respect throughout the entire whirling body, so long as its integrity is preserved. But the oblique inclination which the spiral movement also has to the plane of the horizon is in opposite directions as regards the interior and exterior portions of the revolving mass. Thus, in the outward portion of the whirlwind the tendency of this movement is obliquely downward, where the axis is vertical; but in the interior portion the inclination or tendency of the spiral movement is upward. This fact explains the ascensive effects which are observed in tornadoes and in more diminutive whirlwinds. 3. Owing to the increased pressure of the circumjacent air in approaching the earth's surface, the normal course of the gradually descending movement, in a symmetric whirlwind, is that of an involuted or closing spiral; while the course of the interior ascending movement of rotation is that of an evolved or opening spiral. Hence, the horizontal areas of the higher portions of the whirl exceed greatly those of its lower portions. 4. The area of the ascending spiral movement in the vortex, as it leaves the earth's surface, is by far the smallest portion of the whirling body; for the reason that the rotation here is proportionally more active and intense, being impelled by the aggregated pressure and momentum of the more outward portion of the whirlwind as it converges from its larger area, on all sides by increasingly rapid motion, into the smaller area of ascending rotation.* That this interior portion of the whirl resembles an inverted hollow cone or column, with quiescent and more rarified air at its absolute centre, may be inferred from the observations which have been made in the axial portions of the great cyclones. Into this axial area of the tornado the bodies forced upward by the vortex cannot fall, but will be discharged outward from the ascending whirl. The columnar profile of this axial area sometimes becomes visible, as in the water-spouts so called. 5. Accessions caused by circumjacent contact and pressure are constantly accruing to the whirling body, so long as its rotative energy is maintained. A correlative diffusion from its ascending portion must necessarily take place towards its upper horizon; and this is often manifested by the great extent or accumulation of cloud which results in this manner from the action of the tornado. In other words, there is a constant discharge from the whirling body in the direction of least resistance. 6. The spirality of the rotation and its inclination to the horizon, in the great portion of the whirl which is exterior to its ascending area, is not ordinarily subject to direct observation. Nor is the outline or body of the more outward portion of the whirlwind at all visible, otherwise than in its effects. 7. In *aqueous* vortices the axial spiralities of the exterior and interior portions

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* The law of increment in the velocity of the whirlwind, as it gradually converges into smaller areas by its spiral involution, is that which pertains to other bodies when revolving around interior foci towards which they are being gradually drawn or pressed nearer and nearer in their involute course; the line of focal or centripetal pressure, thus sweeping *equal areas in equal times*, at whatever diminution of distance from its centre, except as the velocity may be affected in degree by the resistance of other bodies. Such resistance is of little effect in a tornado, because its revolving mass is mainly above all ordinary obstacles, such as orchards and forests, into which the spirally *descending* and accelerated blast, near the contracted extremity of the inverted and truncated cone of the whirl, penetrates with constant freshness and intensity of force, already acquired in the higher and unobstructed region.

are in reverse direction to those in the atmosphere, the descending spiral being nearest to the axis of the vortex. Hence, lighter bodies, and even bubbles of air, are often forced downward in the water in the manner in which heavier bodies are forced upwards in the atmosphere. The foregoing is simply a statement of results which I have derived from a long course of observation and inquiry. It does not include the partial and imperfect exhibitions of whirlwind action which often occur, nor the various movements and phenomena which are collaterally associated with tornadoes and whirlwinds, some of which are of much significance.—(*American Annual of Scientific Discovery*, 1857.)

OBITUARY.

Sketch of the Life of Robert Brown, taken chiefly from articles in the "Gardener's Chronicle," the "Times," and the "Athenæum."

Robert Brown was born at Montrose on December 21, 1773. His father was a Scottish Episcopal clergyman in that town, who died in November 1791, and was buried in the Canongate churchyard, in the burying-ground belonging to the family of Bishop Keith. His mother died in 1816, and was interred in the same place. His friend, Mr Bennett, is now, in compliance with his wishes, preparing to erect a tablet to the memory of the above. He was educated at Montrose Grammar School, where he was a schoolfellow of Joseph Hume. He entered as a student at Marischal College, Aberdeen, and afterwards studied medicine at Edinburgh, where he attended the botanical class of the University, taught by Dr Rutherford. He completed his studies in 1793, and took the diploma of surgeon. In the same year he was appointed assistant surgeon and ensign to a regiment of Scotch fencibles, stationed in the north of Ireland. He remained there till the end of the year 1800. During his residence in Ireland he prosecuted botany with vigour, and became acquainted with a zealous botanist, Captain Dugald Carmichael, who was then serving in the same regiment. His discovery of a rare and curious moss (*Glyphomitrion Daviesii*) made him known to Sir Joseph Banks, and a friendship was thus commenced between these two eminent men which only terminated with death, and which has materially influenced the progress of botanical science in Britain.

The Admiralty having resolved to fit out an expedition for the survey and exploration of the coast of Australia, Mr Brown, at the recommendation of Sir Joseph Banks, was selected to accompany its commander, Matthew Flinders, as naturalist, in H.M.S. "Investigator." Mr Brown was also accompanied by Ferdinand Bauer as botanical draughtsman, and by Mr Good as gardener. The expedition further included William Westall as landscape-painter; and among the midshipmen was Sir John Franklin, with whom Brown formed a most intimate friendship. The ship sailed in 1801; and after touching at Madeira and the Cape of Good Hope, arrived in the following year at King George's Sound, on the south-west coast of Australia. During a three weeks' stay at this place, Mr Brown collected 500 species of plants, the greater part of which were new to science. After botanizing at various other points along the south coast, Mr Brown landed at Port Jackson, and remained there for several weeks.

In July 1802, the northern survey commenced at Sandy Bay, in lat. 25°, and continued along the north-eastern and northern shores of Australia and the Gulf of Carpentaria to the Pelew and Wellesley's Islands (where the *Livistona australis* was discovered), and then to Wessel's Islands, long. 136° E. Here the rotten state of the "Investigator's" timbers, the ill health of Captain Flinders, and the appearance of scurvy amongst the crew, rendered it necessary to bear up for Timor, where they obtained provisions. Thence they steered along the west and south coasts of Australia, passed a second time through Bass's Straits, and arrived at Port Jackson on June 9, 1803, having lost many of their crew by dysentery, and among others, Peter Good the gardener, after whom Brown named the leguminous genus *Goodia*. The ship in which the expedition sailed was condemned as unseaworthy at Port Jackson in 1803. Captain Flinders then sailed for England in a hired vessel, the "Porpoise;" while Messrs Brown, Bauer, and Allen remained behind, with the intention of exploring the colony for eighteen months, at the end of which period Captain Flinders expected to rejoin them in another ship, for the prosecution of the survey.

The "Porpoise," however, was wrecked on her homeward voyage, in Torres' Straits, and Flinders and a few companions reached Port Jackson in an open boat. Here the party procured a schooner, with which they proceeded to the wreck, and rescued the remainder of the crew. Subsequently Captain Flinders proceeded by way of Timor and Mauritius; and being compelled by the leaky state of the vessel, to put into Port Louis, he was treacherously seized by the French governor, Captain Decaisne, although Napoleon had granted a free pass to his expedition. He was kept partly in prison and partly on parole from December 1803 till June 1810.

Brown and his companions, in the meantime, examined the Blue Mountains and other distant parts of New South Wales. They also visited Bass' Straits and Van Dieman's Land, and made extensive collections of plants. They resided at a station on the River Derwent for many months, including the period of the foundation of the town of Hobarton.

As Captain Flinders did not return, the party returned to England in October 1805, bringing with them a collection of 4000 species of plants, and a large number of drawings. All the living plants obtained during the survey perished in the wreck of the "Porpoise." Soon after his return Brown was appointed librarian to Sir Joseph Banks, in room of Dr Dryander, and he also became librarian of the Linnean Society. One of his earliest papers was published, during his residence in Edinburgh, in the "Transactions of the Wernerian Society of Edinburgh," on the family of *Asclepiadeæ*, an order of plants established by him. This paper showed his power of wonderful research, his capability of examining the structure of plants, and the acuteness and accuracy with which he could trace the development and physiology of organs. He published the results of his Australian researches partly in his "Prodromus Floræ Novæ Hollandiæ," which appeared in 1810, and partly in the "Appendix to the Narrative of Captain Flinder's Voyage," published in 1814. In his "Prodromus," he gave an account not only of the plants collected by himself, but also of those collected by Sir Joseph Banks during Captain Cook's first voyage. The work was published as a first volume, but it was never succeeded by a second. Its descriptions extend from Ferns to Goodenoviæ. It may be said to have been the first British botanical work in which a scientific classification of plants, according to the natural system, is given. Brown must be looked upon as the introducer of this system into Britain; and in this respect he showed himself to be a truly philosophical botanist, much in advance of his contemporaries in this country.

A critic in the "Edinburgh Review" had made rather free remarks on the classicality of the Latin of the Prodromus, at which the author took offence, and recalled the volume; so that it has become rather a rare work, and is generally only known through Dr Nees von Esenbeck's reprint in the "Vermischte Schriften." However, in 1830, he seemed to think better of his production, and issued a supplement, the only one that ever appeared. His second great work, "Plantæ Javanicæ Rariores," was published in conjunction with Dr Horsfield and Mr J. J. Bennett, and was completed within the years 1838–52. Of his other principal publications, we can only undertake to give the headings; but they will be sufficient to show the universality of his botanical knowledge, viz.:—"Observations on the Herbarium collected by Professor Christian Smith in Tuckey's Expedition on the Congo;" "Chloris Melvilleana, being Plants collected on Melville Island in Captain E. Parry's

Expedition;" "Characters and Description of Kingia," a genus named after the late Captain Ph. King; "Observations on Plants collected in Denham and Clapperton's Expedition to Central Africa;" "General Remarks, Geographical and Statistical, on the Botany of Terra Australis;" "On Proteaceæ;" "Botanical Appendix to Captain Strutt's Expedition to Central Australia;" "Observations on Organs and Mode of Fecundation in Orchideæ and Asclepiadeæ;" "On the Fructification of Mosses;" "On Woodsia, a Genus of Ferns;" "On Compositæ;" "On some Remarkable Deviations from the usual Structure of Seeds and Fruits;" "Character and Description of Lyellia;" "Remarks on Leptostomum and Buxbaumia;" "Account of the Genus Rafflesia;" and, "On an undescribed Fossil Fruit—Triplosporite," the last named being that with which he concluded his scientific labours; it was published in the Transactions of the Linnean Society in 1851. In 1828 he published, in a separate form, "A brief account of Microscopical Observations on the Particles contained in the Pollen of Plants, and the General Existence of Active Movements in Organic and Inorganic Bodies." These movements he was the first to point out, and to draw attention to their importance. On the Continent it is customary to allude to the phenomena as "Brunonian movements." His writings, when compared with those of many of his contemporaries, are not very numerous; but they have, nevertheles, exercised a lasting influence on botanical science; and no man had ever less reason to regret anything he had written at the commencement of his career than Robert Brown. That he possessed a most wonderfully rich store of knowledge is a fact that becomes evident by perusing his papers; and it will ever be a source of the deepest regret that he has not published more of those accumulated treasures, all of which were irrevocably lost to science when, on the morning of the 10th of June, the cold hand of death laid their possessor low for ever.

Professor George Wilson makes the following remarks in regard to Brown in the "Athenæum" for June 26:—Brown was so modest and undemonstrative a man that it may be feared he has carried to the grave much knowledge on many points which all lovers of science would have preferred should not die with him. On one of these points, interesting to a wide circle of physicists, documentary evidence may yet exist, and it may be well to draw the attention of those in a position to settle the matter towards the question of such evidence existing. Robert Brown took a great interest in the much disputed problem—'Was Watt or Cavendish the discoverer of the composition of water?'—and strongly favoured the claims of the latter, whom he had often met in early life. He supplied Professor Wilson with information regarding Cavendish for the Life of that philosopher, written for the Cavendish Society, and expressed, though with his customary caution and reserve, an unhesitating opinion in favour of Cavendish's originality and integrity. On one of his latest visits to Edinburgh, after the publication of the "Life of Cavendish," he recurred in conversation to the water controversy, and startled Professor Wilson by stating, that there existed a document or documents which would put Cavendish's claims, as the discoverer of the composition of water, beyond dispute. He would not enter into any particulars. It is probable that among his papers, or among those which he inherited from Sir Joseph Banks may be found documents bearing on the rival claims of Cavendish and Watt, which may deserve a careful examination.

On the death of Sir Joseph Banks in 1823, Brown became, by his will, the possessor of the Banksian Herbarium for life (after which it was to pass to the British Museum), together with the remainder of the lease of Sir Joseph Bank's house in Soho Square, which had become the centre of London scientific society. Brown offered the Herbarium to the British Museum, on the condition that he should be appointed keeper, with a suitable salary, which offer was accepted. The Banksian Herbarium forms the most valuable part of the General Herbarium at the British Museum. He continued until his death to occupy that portion of the house in Soho Square which looked into Dean Street, the remaining portion being let by him to the Linnean Society until the expiry of the lease, soon after which the Society removed to Burlington House, where apartments have been assigned to it by Government, as also to the Royal and the Chemical Societies.

On 20th November 1798 he was elected an Associate of the Linnean Society of London. In 1811 Brown became a Fellow of the Royal Society, and has several times been elected on the council of that body. In 1822 he became a Fellow of the Linnean Society. In 1832 he received the degree of D.C.L. from the University of Oxford, in company with Dalton, Faraday, and Brewster. In 1833 he was elected one of the eight Foreign Associates of the French Academy of Science, his competitors being Bessel, Von Buch, Faraday, Herschell, Jacobi, Meckel, Mitscherlich, Oersted, and Plana. In 1839 the Royal Society awarded him the highest honour at their disposal,—viz., their Copley Medal,—for his discoveries during a series of years on the subject of vegetable impregnation. In 1849 he succeeded the Bishop of Norwich as President of the

Linnean Society, which office he held until Mr Bell's election in 1853, still retaining, however, the office of Vice-President. Under the cognomen "Ray," he was a Member of the Imperial L. C. Academy of Germany; he was besides enrolled an Honorary Member in the lists of most of the minor societies in all parts of the old and new world. During the administration of Sir Robert Peel, he received a pension of L.200 as a recognition of his scientific merits. He also received the decoration of the highest Prussian Civil Order, "Pour le Merite," of which his friend and survivor, at the age of 88, the Baron Von Humboldt, is chancellor. Humboldt long since called him "Botanicorum facile princeps," a title to which all scientific botanists readily admitted his undisputed claim.

His interest in the progress of science, and especially in the Royal and Linnean Societies, continued unabated to the last; and his wonderful and almost unique powers of mind, his memory and his sagacity, remained wholly unimpaired till the very day of his decease. In the spring of this year he was attacked with bronchitis, from which he recovered, but which left him for some weeks in a very enfeebled state. Dropsy and loss of appetite supervened, under which he gradually sunk, suffering little pain, perfectly conscious of his condition, and retaining to the end his singularly placid demeanour, his affectionate interest in all who were dear to him, and a most tranquil and peaceful frame of mind.

He died at the age of 83, surrounded by his collections, in the room which had previously been the library of Sir Joseph Banks. He was buried on 15th June in the cemetery at Kensal Green, and his funeral was attended by a large body of his scientific and personal friends.

There are few men among us who, with an equal claim upon the gratitude of their fellow-countrymen, enjoyed less popularity, or obtained less consideration on the part of society in general, than the deceased. Beyond the narrow circle of scientific men his illustrious name was, and is, almost unknown in Great Britain; but go wherever you will on the continent of Europe, or the remotest corners of the globe where science is cultivated, and you will discover a familiarity with his writings and researches truly astonishing. Foreigners have often expressed their surprise on finding how little we seemed to appreciate this great naturalist; but the fact of the matter was, the deceased neither seemed to care to enjoy popularity, nor did he care to avail himself of all those well-known means by which people bring themselves into public notice. If at all ambitious of fame, he trusted to the more lasting immortality that would result from his sterling scientific memoirs; and if he calculated thus he was not mistaken, for so long as botanical science is studied he will occupy a predominant place in the *walhalla* of its heroes.

Mr J. J. Bennet, in the "Times," remarks:—"Those who were admitted to the privilege of his intimacy, and who knew him as a man, will bear unanimous testimony to the unvarying simplicity, truthfulness, and benevolence of his character. With an appearance of shyness and reserve in the presence of strangers, he combined an open-heartedness in relation to his familiar friends, and a fund of agreeable humour, never bitter or caustic, but always appropriate to the occasion, the outpourings of which it was delightful to witness. But what distinguished him above all other traits was, the singular uprightness of his judgment, which rendered him on all difficult occasions an invaluable counsellor to those who had the privilege of seeking his advice. How profoundly these admirable qualities had endeared him to the hearts of his friends was unmistakeably manifested by the sympathetic tenderness with which his last hours were watched and soothed. 'It was in the year 1810,' says one of his distinguished friends, who contributed greatly to relieve the sufferings of his last illness, 'that I first became acquainted with Mr Brown, within three feet of the same place, in the same room, where I saw him so nearly drawing his last breath three days ago. He was the same simple-minded, kind-hearted man in November 1810, as he was in June 1858—nothing changed but as time changes us all.'"

A writer in the "Athenæum" says,—Though less popularly known as a man of science than many of his contemporaries, those whose studies have enabled them to appreciate the labours of Brown, rank him altogether as the foremost scientific man of this country. He takes this position not so much from his extensive observations on the structure and habits of plants, as from the philosophical insight he possessed, and the power he displayed of applying the well-ascertained facts of one case to the explanation of doubtful phenomena in a large series. Till his time, botany can scarcely be said to have had a scientific foundation. It consisted of a large number of ill-observed and badly-arranged facts. By the use of the microscope, and the conviction of the necessity of studying the history of the development of the plant, in order to ascertain its true structure and relations, Brown changed the face of botany. He gave life and significance to that which had been dull and purposeless. His influence was felt in every direction; the microscope became a necessary instrument in the hands of the philosophical botanist, and the history of development was the basis on which all improvement in classification was carried on. This influence extended from the vegetable to the animal kingdom. The researches of Schleiden on the vegetable cell, prompted by the observations of Brown, led to those of Schwann on the animal cell; and we may directly trace the present condition of animal physiology to the wonderful influence that the researches of Brown have exerted upon the investigation of the laws of organization. Even in zoology the influence of Brown's researches may be traced in the interest attached to the history of development in all its recent systems of classification. Brown had, in fact, at the beginning of the present century, grasped the great ideas of growth and development, which are the beacon lights of all research in biological science, whether in the plant or animal world. Whilst Brown's influence was thus great, his works are not calculated to attract popular attention. He was of a diffident and retiring disposition, shunning whatever partook of display, and anxious to avoid public observation. Thus it is that one of our greatest philosophers has passed away without notice, and many will have heard his name for the first time with the announcement of his decease. But for him an undying reputation remains, which must increase as long as the great science of life is studied and understood.

PUBLICATIONS RECEIVED.

A Manual of Applied Mechanics. By Mr John Macquorne Rankine, Regius Professor of Civil Engineering and Mechanics in the University of Glasgow.—*From the Publisher.*

L'Institut, for March, April, May, June, July, and August 1858.—*From the Editor.*

Natural History Review, for January, April, and July 1858.—*From the Editors.*

The Canadian Naturalist and Geologist for February, April, and June 1858.—*From the Editors.*

The Quarterly Journal of the Geological Society, May 1858.—*From the Society.*

Transactions of the Manchester Philosophical Society, for March and April 1858.—*From the Society.*

Proceedings of the Royal Geographical Society of London, Vol. II., Nos. 1 and 2.—*From the Society.*

Quarterly Journal of the Chemical Society for April 1858.—*From the Society.*

American Journal of Science and Arts, for March 1858.

Geology of the Extinct Volcanoes of Central France. By G. Poulett Scrope.—*From the Publisher.*

Bibliotheque Universelle, Revue Suisse et Etrangère. Archives des Sciences Physiques et Naturelles. No. 3. 20th March 1858.

Manual of the Mineralogy of Great Britain and Ireland. By Robert P. Greg and Wm. G. Lettson.—*From the Authors.*

The Atlantis, a Register of Literature and Science. No. 2, for July 1858.—*From the Editor.*

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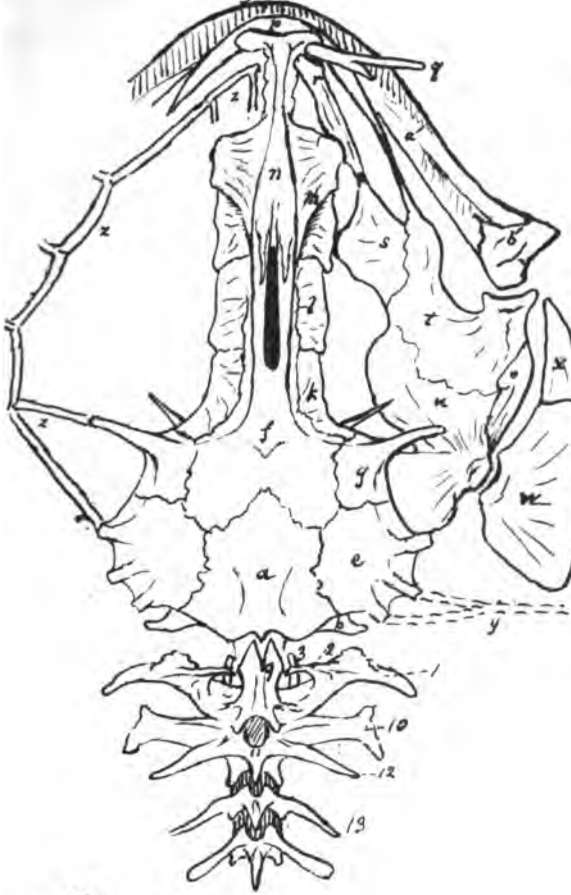

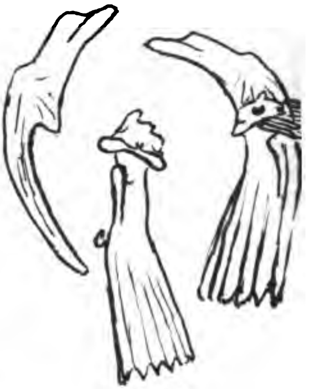

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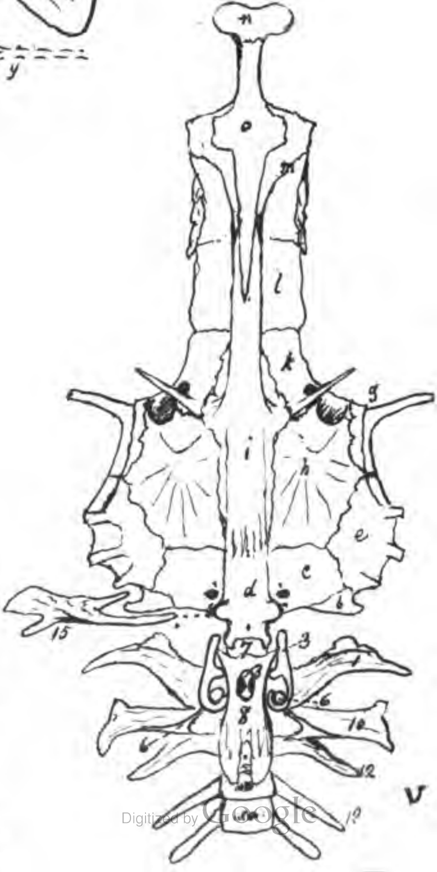

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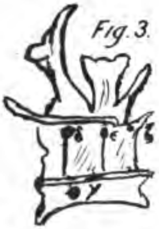

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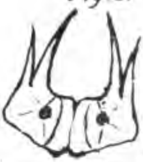

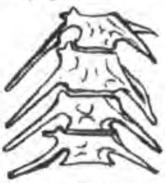

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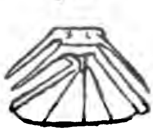

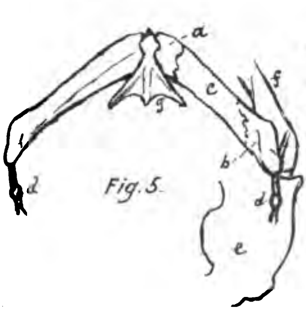

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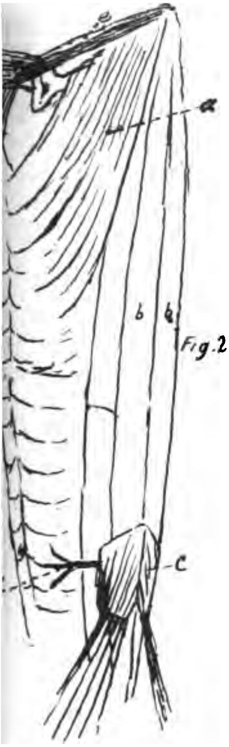

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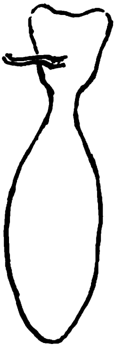

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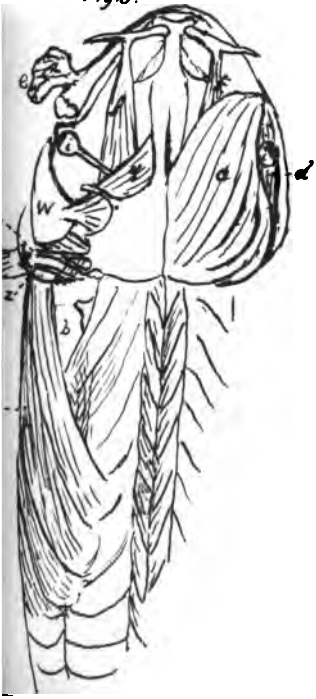

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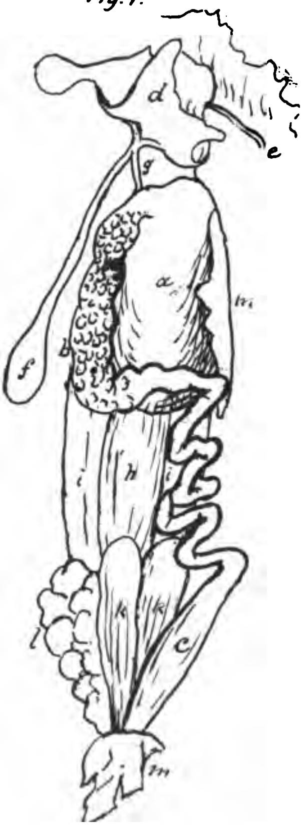

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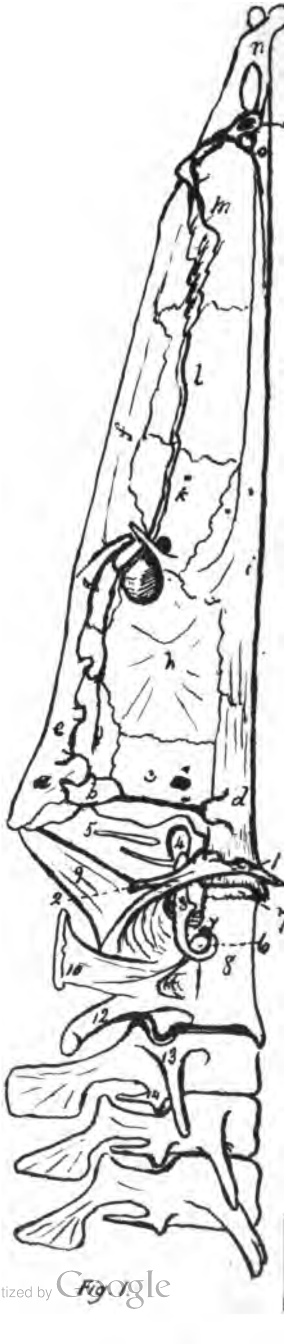

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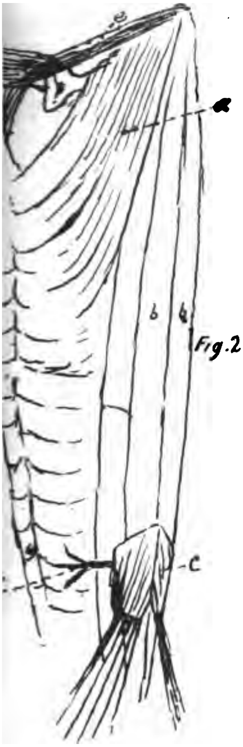

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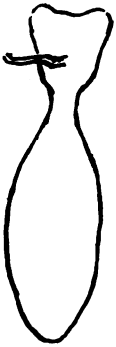

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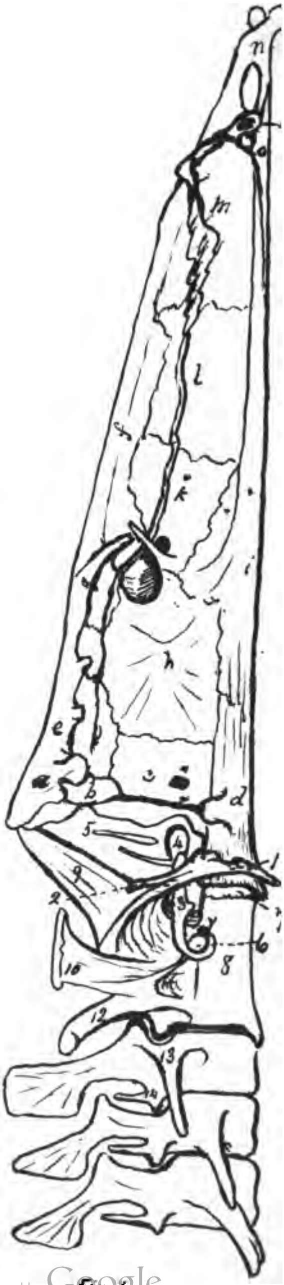

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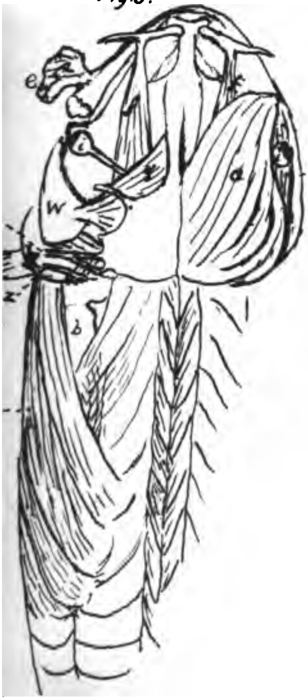

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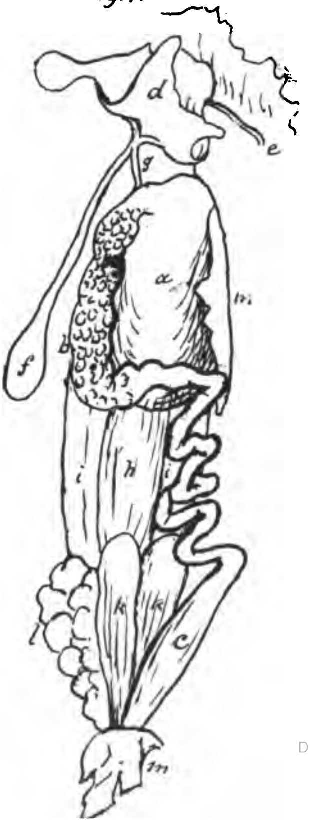

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